



abstracts

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ABSTRACTS



March 15–17, 2010

*Author presenting paper

Animal Behavior, Housing, Well-Being

1 Pasture characteristics and microclimate effects on the temporal/spatial distribution of beef cows grazing Midwestern cool-season grass pastures. D. A. Bear*, J. R. Russell, and D. G. Morrical, *Iowa State University, Ames.*

Five southern Iowa cow-calf farms were used to evaluate the effects of pasture characteristics and microclimatic conditions on the temporal/spatial distribution of cattle grazing cool-season grass pastures with streams and/or ponds. Pastures ranged from 14 to 129 ha with varying proportions of cool-season grass, legume, weed, and brush species, bare ground, and shade. Cows were Angus or Angus-cross on four farms with Mexican Corriente on the remaining farm. During spring, summer, and fall in 2007 and 2008, 2 to 3 cows per farm were fitted with Global Positioning System collars to record cattle positions at 10 min intervals for periods up to 14 d. Microclimate data were collected with HOBO data loggers at 10 min intervals over the grazing seasons. Pasture characteristics, such as streams, pond, and fence lines, were referenced and used to establish zones in the pastures including in the stream or pond, within 30.5 m, or greater than 30.5 m from the stream or pond. Mean proportions of observations when cattle were in the water source did not differ between farms. However, mean proportions of time cattle spent within 30.5 m and greater than 30.5 m of the water source differed ($P < 0.05$) between farms. The probability of that cattle were within the streamside zone (the area in and within 30.5 m of the water source) increased with increasing ambient temperature and differed between farms. Regressions predicting proportions of time that cattle were within the streamside zone from the proportion of pasture sites vegetated with endophyte-infected tall fescue or the proportions of pasture shade in the riparian zones were not significant. However, the proportion of time cattle were within the streamside zones was related ($P < 0.05$) to pasture size and the proportion of the total area of each pasture in the streamside zone. Temporal/spatial distribution of grazing cattle is related to pasture size and shape, and therefore, the risk of nonpoint source pollution of surface waters may be greater on small and/or narrow pastures than large pastures.

Key Words: cattle distribution, global positioning system, nonpoint source pollution

2 Effect of disposition score on feedlot performance, carcass traits and profitability of beef calves fed in the Iowa Tri-County Steer Carcass Futurity. G. D. Fike*¹, L. R. Corah¹, M. E. King¹, and W. D. Busby², ¹*Certified Angus Beef LLC, Wooster, OH*, ²*Iowa State University, Ames.*

Beef calves (n=47,410) fed at 18 Iowa feedlots through the Iowa Tri-County Steer Carcass Futurity over eight years (2002–09) were used to evaluate the effect of disposition score (1=docile; 6=very aggressive) on feedlot performance, carcass traits and profitability. A common diet was fed and similar implant and health programs were administered to all calves. Calves were sorted and harvested when visually determined to have one cm of fat cover. Calves were divided into three groups based on disposition score: docile (DC), restless (R) and nervous to very aggressive (NVA). Unless otherwise stated, each of the three means for each outcome was different from all other means ($P < 0.05$). DC, R and NVA calves had similar feedlot delivery weights. Although disposition score significantly affected days on feed, the difference between the highest and lowest mean DOF was less than one day. As disposition score increased, final weights (537.9, 531.2 and 519.9 kg), hot carcass weights (330.7, 327.6 and 322.8 kg), ADG (1.46, 1.43 and 1.37 kg/d) and marbling scores (400=Sm⁰; 431.7, 422.1 and 401) decreased while cost of gain increased (1.33, 1.48 and 1.51 USD/kg). NVA calves were less efficient (6.97 kg/kg) compared with D (6.86 kg/kg) and R (6.84 kg/kg) calves. Rib fat was identical for DC and R calves (1.14 cm), but was lower for NVA calves (1.05 cm). Of the black-hided Angus-type calves eligible for the *Certified Angus Beef* (CAB) program, higher disposition scores lowered CAB acceptance rates (20.65, 15.21 and 9.08% for DC, R and NVA calves, respectively; $P < 0.0001$). DC calves were the most profitable (46.63 USD/hd) followed by R calves at 26.16 USD/hd. NVA calves returned the least profit at 7.62 USD/hd. Docile calves had better feedlot performance, improved carcass merit and greater profitability than those calves that were more aggressive.

Key Words: disposition score, feedlot performance, carcass traits

3 The effect of selection for residual feed intake on general behavioral activity in Yorkshire gilts. L. J. Sadler^{*1}, A. K. Johnson¹, S. M. Lonergan¹, D. Nettleton², and J. C. M. Dekkers¹, ¹*Iowa State University, Ames*, ²*Iowa State University, Ames*.

The objective of this study was to determine the effect of selection for reduced residual feed intake (RFI) on behavior and activity of gilts in their home pen. A total of 192 gilts were used, 96 were from a line that had been selected for low RFI over 5 generations (LRFI) and 96 from a randomly bred control line (CRFI). Gilts were housed in 12 pens (16 gilts/pen; 0.82 m²/gilt) containing 8 gilts from each line in a conventional grow-finish unit. Each pen had ad libitum access to feed and water via a 1-space electronic feeder and a 2-nipple style waterer. Twelve hours of video footage were collected on the day of placement and then every 4 wk for 3 more observational periods. Video was scored using a 10-min instantaneous scan sampling technique for four postures (standing, lying, sitting and locomotion) and one behavior (at drinker). Categories of active (standing, locomotion and at drinker) and inactive (sitting and lying) were also created. Data were analyzed with Proc Mixed of SAS. The data were analyzed separately for the day of placement and the three subsequent rounds. General activity data were summarized on a percentage basis by each posture and behavior and subjected to an arcsine square root transformation to help normalize data and stabilize variance. There were no differences between genetic lines for all postures and behavior at drinker on the day of placement. However, over subsequent rounds it was observed that LRFI gilts spent less time standing ($P = 0.03$; 13.7 vs. $15.2 \pm 0.9\%$), more time sitting ($P = 0.05$; 2.5 vs. $2.1 \pm 0.3\%$), and were less active overall ($P = 0.03$; 16.9 vs. $18.5 \pm 0.8\%$). In conclusion, on the day of placement there were no behavioral differences between genetic lines, but behavioral differences were observed between genetic lines over subsequent rounds, with LRFI gilts becoming less active. This research was funded by grants from the National Pork Board and the Iowa Pork Producers Association.

Key Words: behavior, gilts, residual feed intake

4 Association between claw lesion scores, lameness and sow gestation housing systems. S. S. Anil^{*1}, L. Anil², J. Deen¹, S. K. Baidoo², M. E. Wilson³, and T. L. Ward³, ¹*University of Minnesota, St. Paul*, ²*University of Minnesota, Waseca*, ³*Zinpro Corporation, Eden Prairie, MN*.

Housing system (stall vs. group) may impact the development of claw lesions in pigs. Comparison of lesion scores in different housing systems requires similarity in genetics, nutrition and management. This study compares the lesion scores in different claw areas in lateral and medial claws and in front and hind limbs of sows (mixed parity) housed in conventional gestation stalls ($n=233$) and in group pens with electronic sow feeders (ESF; $n=323$). Sow claws were examined for lesions during days 60-70 of gestation using Zinpro FeetFirst lesion scoring system. Lesions (heel lesions- H, overgrown heels- OGH, claws-OGC and dew claws-OGDC, white line cracks- WL, vertical and horizontal side wall cracks- SWV and SWH and sole cracks-S) were scored on a scale of 1 to 3. Total lesion score for a claw was obtained by adding the lesion scores for various areas in the claw. Sows were also categorized into lame or non-lame based on the willingness to bear weight equally on all limbs without favoring any particular limb. Data were analyzed using Kruskal-Wallis test and stepwise logistic regression (SAS V 9.1). Regardless of the housing system, lame sows had higher scores for total lesions, total lateral claw lesion and total SWV lesions; ($P < 0.05$ for all) than non-lame sows. Group-housed sows had higher ($P < 0.05$) lesion

scores in all claw areas than stall-housed sows. With the housing system in the model, the likelihood of lameness increased ($P < 0.05$) by 13, 20 and 17%, respectively, with every unit increase in scores for OGC, total WL and total SWV cracks. Separate, stepwise logistic regression for the housing systems indicated that the likelihood of lameness increased by 13% and 28% in sows housed in pens with ESF and in stalls, respectively, for every unit increase in the total SWV score. This study indicated higher claw lesion scores in lame sows compared to non-lame sows, in sows housed in group pens with ESF compared to those in stalls and a higher likelihood of lameness in those sows with OGC and higher scores for WL and SWV lesions. Higher score for SWV crack appeared to be a risk factor for lameness in both housing systems.

Key Words: claw lesions, lameness, sow housing systems

5 Effect of parity on pre-weaning mortality and growth performance of piglets in a bedded, group-farrowing system. Y. Z. Li^{*1}, J. E. Anderson², and L. J. Johnston¹, ¹*University of Minnesota, St Paul*, ²*University of Minnesota, Morris*.

A study was conducted to investigate the effect of sow parity on pre-weaning mortality and growth performance of piglets in a group-farrowing system. Multiparous sows ($n = 119$) from 8 breeding groups were categorized as parity 1, 2, 3, or 4+ (parity 4 to 10). Sows farrowed in a straw-bedded, group-farrowing system where 8 sows shared a communal area, and farrowed in individual pens. Litter size was equalized (11 to 13 piglets) by cross-fostering within 24 h after farrowing. Piglets were weighed individually at birth, at the time farrowing pens were removed (d 10), and at weaning (wk 4). Dead piglets were weighed and removed on a daily basis. Farrowing behavior of 9 focal sows from each parity was videotaped. Data were analyzed using the GLIMMIX procedure of SAS with parity as a fixed effect, and breeding group as a random effect. Young sows (parities 1, 2, and 3) had larger live born litter size than old sows (12.4 vs. 11.1, SE = 0.54; $P = 0.05$). After litter size was equalized, parity 1 sows tended to wean more piglets (10.8 vs. 9.5 pigs/litter, SE = 0.39; $P = 0.06$) with lower piglet mortality (10.9 vs. 21.8% of live litter size, SE = 3.09; $P = 0.06$) compared with parity 3 and 4+ sows. Parity 1 sows produced lighter piglets at birth (1.5 vs. 1.6 kg, SE = 0.05; $P < 0.01$) and at weaning (7.3 vs. 8.2 kg, SE = 0.45; $P < 0.01$) compared with sows of other parities. No differences were observed in farrowing duration (181, 162, 187, and 248 min for parity 1, 2, 3, and 4+, respectively, SE = 42.3), inter-pig birth intervals (13, 16, 17, and 23 min/pig, SE = 2.6), postural changes during farrowing (3.9, 4.5, 2.4, and 2.7 changes/hr, SE = 1.28), and ADG of piglets (222, 236, 227, 227 g for piglets farrowed by parity 1, 2, 3, and 4+ sows, respectively, SE=12.3) among sow categories. The results indicate that parity 1 sows had lower piglet mortality and weaned larger litters with lighter piglets compared with parity 3 and 4+ sows in a straw-bedded farrowing system.

Key Words: piglet mortality, parity, loose farrowing

6 Effects of farrowing induction on sow and piglet performance. C. C. Selby^{*}, H. M. Smith, T. J. Safranski, and W. R. Lamberson, *University of Missouri, Columbia*.

Induction of parturition is a production tool used in sow operations to promote cross-fostering and improve management of farrowing stock. Previous studies indicated that a reduction in gestation length may be associated with increased morbidity and mortality. Therefore, the objective of this study was to determine the effects of induction on sow and litter performance. Records on 472 parity one and two sows and

5493 piglets were collected during July and August on a commercial farm. Induction of parturition was accomplished by using Lutalyse injections (i.m.) at 0300 and 0600 to sows which had not initiated parturition by d 113, 114, or 116 of gestation. Oxytocin was given i.m. at 0530 the following morning to sows that had yet to farrow. Piglets were cross-fostered (within treatment groups) within 24 hours and processed on d 2. Data were analyzed using a mixed model analysis of variance with Fisher's LSD to determine differences in means. Categorical response variables were analyzed by using SAS Proc Genmod with a logit function and a binomial distribution. Spontaneous farrowing was attributed to the onset of farrowing prior to Lutalyse injection. Induced and spontaneous farrowing occurred in 65% and 35% of the sows, respectively, but differed by treatment group. For the remaining analyses, treatment groups were pooled. Average gestation length was 114.96 ± 0.07 d and 114.53 ± 0.09 d for induced and spontaneous groups, respectively ($P < 0.01$). Spontaneous farrowing sows had a higher ($P = 0.06$) number born alive than induced sows with means of 12.2 ± 0.24 and 11.6 ± 0.20 , respectively. No differences were observed between treatment groups for within litter average daily gain during lactation, probability of live birth, spraddles, still born, or mummies. The percentage of sows expressing estrus within 7 d of weaning was 65.1% for the induced group and 34.9% for the spontaneous group ($P < 0.01$). The probability of subsequent farrowing for induced and spontaneous groups sows were 0.81 and 0.86, respectively ($P = 0.26$). These results indicate that induction of farrowing can be used with minimal effects to the herd.

Key Words: farrowing induction, litter performance, swine

7 Measures of well-being in response to variation in ambient temperature and light intensity for mature gilts housed in crates during breeding and early gestation. D. Canaday*, A. Visconti, A. DeDecker, J. Salak-Johnson, and R. Knox, *University of Illinois, Urbana*.

The effects of variation in the housing environment of breeding sows maintained in crates is of great interest for assessing measures of well-being, including immune function and physiology. This experiment was designed to test whether variation in ambient temperature and light intensity for females kept in crates during breeding and early gestation would impact measures of well-being. In multiple replicates, cyclic gilts ($n=72$) were synchronized and assigned by body weight in a 3 x 2 factorial treatment design to a temperature (HOT: 30°C, THERMAL NEUTRAL [TN]: 20°C, COLD: 16°C) and light intensity (DIM: <40 Lux, BRIGHT: >350 Lux) treatment. At onset of estrus, all gilts were AI. Feed intake, body temperature, and endocrine and immune status were measured on d -7, 0 (estrus), 7, 14, 21 and 28 post-breeding. Gilts were sacrificed at d 30 of gestation for evaluation of pregnancy and litter characteristics. Treatment did not affect reproduction, including measures of estrus expression, ovulation and pregnancy rate and litter size. Cortisol was greater ($P < 0.05$) in gilts kept in COLD (32.67 ng/mL) than in those kept in TN (29.43 ng/mL) or HOT (27.89 ng/mL) treatments. Day of sampling affected cortisol with d 14 and 28 post-breeding measuring less than other days ($P < 0.0001$). Neutrophil phagocytosis was greater on days 21 and 28 post-breeding than any other day ($P < 0.001$), but temperature and lighting treatments had no effect. Lipopolysaccharide-induced proliferative response was greater ($P = 0.01$) on day 28 than any other day and greater ($P=0.05$) among gilts kept in BRIGHT than DIM lighting treatment. Percent of neutrophils and the neutrophil:lymphocyte ratio were higher ($P < 0.0001$) among gilts kept in cold (27.6%, 0.47) than TN (23%, 0.36) or HOT (21.8%, 0.33) environments and greater ($P < 0.0001$) on days -7 and 0 than any other

day. Light intensity had no effect on neutrophils. The results suggest that these temperature and lighting levels may have little detrimental effect on the immune status and endocrine profile of gilts housed in crates during breeding and early gestation.

Key Words: housing, immunology, well-being

8 Relationship between start and end weight variation in a group of pigs. E. Magowan*¹, J. Allen^{1,2}, V. E. Beattie², and M. E. E. McCann¹, ¹*Agri Food and Biosciences Institute, Hillsborough, Northern Ireland*, ²*Devenish Nutrition Ltd, Belfast, Northern Ireland*.

Variation in live weight within groups of pigs at slaughter weight can span 40kg. This study aimed to investigate the relationship between the start and end weight variation of a pen of pigs. The post weaning and finishing stages were examined. Start (wean, 8 kg) and end (30 kg) weight coefficient of variation (CV) values from 391 pens of post weaned pigs and start (30 kg) and end weight (95 kg) CV values from 284 pens of finishing pigs were used. Pens contained 10 or 20 pigs. In both data sets the end weight CV was subtracted from the start weight CV and this represented the change in CV. Regression analysis was used to examine the relationships between start weight CV and 1) end weight CV and 2) the change in CV. The relationships between start and end weight CV for both post weaning and finishing pens of pigs were weak ($R^2 = 0.17$ and 0.11 , respectively). However, the relationship between the start weight CV and change in CV for pens of post weaned pigs was found to be significant ($P < 0.001$), fitted a quadratic curve ($y = 1.855x^2 - 1.151x + 0.1153$) and was considered of average strength ($R^2 = 0.459$). The relationship between start weight CV and change in CV for finishing pigs was also significant ($P < 0.001$), fitted a linear line ($y = -0.6894x + 0.0591$) but was weak ($R^2 = 0.372$). The results indicate that start weight CV is a poor predictor of end weight CV. However, it is suggested that, for post weaned pens of pigs, when start weight CV is low (when pigs are uniformly grouped) the CV in end weight will increase. Whereas when the pen contains a more diverse range of weights, the end weight CV may decrease compared to the start weight CV. A similar pattern is present when examining pens of finishing pigs. Although the finishing data set contained fewer extreme values than the post weaning data set, it was noted that end weight CV decreased in most of the pens with a start weight CV over 0.08. In conclusion, extreme uniform grouping (CV < 0.075) of weaned pigs appears to increase end weight (30 kg) CV. Overall, start weight CV was not found to be a good predictor of end weight CV in either post weaned or finishing pens pigs.

Key Words: pigs, weight, variation

9 Effects of farm management, gender and pig temperament on pork quality. J. A. Brown*, I. B. Mandell, P. P. Purslow, and T. M. Widowski, *University of Guelph, Ontario, Canada*.

While differences in the management and individual characteristics of pigs are known to cause variation in physiological responses at slaughter and meat quality, our understanding of these effects and their interactions is poor. In this study, the effects of management, gender and temperament were studied in 637 pigs (307 barrows and 330 gilts) reared on 18 commercial farms and on a research farm. Pigs were slaughtered over a 2 year period at a commercial abattoir in 27 cohorts of 24 animals. Farm classifications were 1) commercial farms with short loading to slaughter time (2-5 h: CS), 2) commercial farms with long loading to slaughter time (8-21 h: CL), or research farm (R). Before transport, temperament

was assessed on-farm using an open door test, with individual pigs identified as bold, intermediate or shy based on their willingness to exit the home pen. Muscle temperature and pH were monitored post-mortem, and meat quality was assessed in loin and ham samples collected at 24 h post mortem. The effects of management, gender and temperament on pork quality were analysed by mixed model ANOVA in SAS. Results showed that pigs from CS farms had lower initial ham temperatures than those from CL farms ($P = 0.039$). Compared to commercially-produced pigs, R pigs had higher drip loss in ham ($P = 0.049$) and tended to produce tougher meat with lower ultimate pH in ham and loin muscle ($P < 0.10$). Barrows produced loin muscle with higher initial temperature ($P < 0.001$), lower initial pH ($P = 0.019$), and lighter color (L*: $P < 0.001$) than gilts. Comparing the different temperaments, shy pigs had lower initial pH in ham ($P = 0.034$) and produced lighter meat (loin: $P = 0.020$, ham: $P = 0.033$) than bold pigs, and both bold and shy pigs produced more tender meat (loin and ham: $P < 0.05$), and higher drip losses in ham ($P = 0.030$) than intermediate pigs. Temperament by management interactions indicated that the effects of temperament on meat quality were greatest in commercial LH and R pigs. In conclusion, both the management and individual characteristics of pigs influence meat quality, and consideration of these effects could result in improvements in the quality and consistency of pork.

10 Effects of floor space during transport and journey time on transport losses and physical indicators of stress in market-weight pigs. C. M. Pilcher^{*1}, M. Ellis¹, M. J. Ritter², J. Brinkmann³, C. L. Puls¹, O. F. Mendoza¹, A. Rojo¹, and B. A. Peterson³, ¹University of Illinois, Urbana, ²Elanco Animal Health, Greenfield, IN, ³The Maschhoffs, Carlyle, IL.

The effects of floor space during transport and journey time on the incidence of transport losses at the plant were evaluated in a study involving 160 loads of pigs (BW 124.7 ± 4.9 kg) using a split-plot design with a 2 × 6 factorial arrangement of treatments: 1) Journey Time (JT) from the farm to the packing plant (main plot) [short (<1 h) vs. long (3 h)] and 2) Transport Floor Space (FS) (subplot) (0.396 vs. 0.415 vs. 0.437 vs. 0.462 vs. 0.489 vs. 0.520 m²/pig). The incidence of dead and nonambulatory pigs and the percentage of pigs in each test compartment exhibiting open-mouth breathing (OMB) and/or skin discoloration (SD) were recorded during unloading at the plant. The effect of FS on the incidence of OMB was dependent on JT (FS × JT interaction; $P < 0.01$). On short journeys, pigs transported at 0.396 and 0.415 m²/pig had higher incidence of OMB than pigs transported at 0.462, 0.489, and 0.520 m²/pig. Also, the incidence of OMB was greater for short than long journeys for every floor space. However, on long journeys, there was no effect of FS on the incidence of OMB. The frequency of SD was greater for pigs transported on short than on long journeys (2.08 vs. 1.30%; $P < 0.001$). Pigs transported at 0.396 m²/pig had higher incidence of SD than pigs transported at 0.462, 0.489, and 0.520 m²/pig, with 0.415 and 0.437 m²/pig being intermediate. Of 17,652 pigs transported in test compartments, 0.24% died or became non-ambulatory during transport or during unloading. There was no effect of FS or JT on the percentage of pigs that were dead on arrival, nonambulatory/fatigued, or nonambulatory/injured at the plant. In summary, pigs transported for <1 h compared to 3 h exhibited higher incidences of physical indicators of stress during unloading at the plant; however, transport floor space and journey time had minimal effects on transport losses.

Key Words: transport, floor space, journey time

11 Effects of pre-sorting on the stress response of market weight pigs during loading and unloading. L. M. Gesing^{*1}, A. K. Johnson¹, K. J. Stalder¹, H. Hill², C. Feuerbach², M. Faga², R. Bailey³, and M. J. Ritter⁴, ¹Iowa State University, Ames, ²Iowa Select Farms, Iowa Falls, IA, ³JBS Swift and Co, Marshalltown, IA, ⁴Elanco Animal Health, Greenfield, IN.

Thirty-three loads (~180 pigs/load) of market weight pigs (n=5802) were used in a complete randomized block design to determine pre-sorting effects on stress responses (during loading and unloading) and transport losses. This study was completed on three commercial grow-finish sites between December and March. Each site had two rooms with both treatment groups represented in each room. The pre-sorted (PRE) treatment had 292 pigs/pen (0.65 m²*pig⁻¹). Internal swing gates were used to manually pre-sort market weight pigs from pen-mates ~18 h prior to marketing. The not pre-sorted (NON) treatment also had 292 pigs/pen (0.65 m²*pig⁻¹) but pigs were not pre-sorted from pen mates prior to loading. During loading, pigs were moved in small groups using sort boards and electric prods if necessary, and loaded on straight deck trailers. Treatments were randomly assigned to a deck, pigs were provided with ~0.41 m²*pig⁻¹, and transported ~1 h to a commercial harvest plant. During loading and unloading, the number of pigs displaying open mouth breathing (OMB), skin discoloration (SD) and muscle tremors (MT) were recorded. At the plant, dead and non-ambulatory pigs were recorded during unloading. Total losses were defined as the sum of dead and non-ambulatory pigs. Data were analyzed using Proc Glimmix of SAS. Lower ($P < 0.0001$) OMB and SD were observed at loading for PRE compared to NON pigs, but there were no differences for MT or non-ambulatory at loading or for stress responses at unloading. No differences existed between treatments for fatigued, injured, total non-ambulatory or total losses (NON=0.27 ± 0.09, PRE=0.33 ± 0.10). In conclusion, pre-sorting market weight pigs had some effect on reduced stress responses on farm. However, pre-sorting pigs prior to loading did not affect stress responses or transport losses at the plant.

Key Words: pre-sort, pig, transport loss

12 Effects of Sirrah-Bios PRRSV-RS vaccine on mortality rate and finisher pig performance. M. L. Potter^{*1}, S. S. Dritz¹, S. C. Henry², L. M. Tokach², J. M. DeRouchey¹, M. D. Tokach¹, R. D. Goodband¹, and J. L. Nelssen¹, ¹Kansas State University, Manhattan, ²Abilene Animal Hospital, P.A., Abilene, KS.

A total of 1,561 pigs (4 d of age) were used to determine the effects of a porcine reproductive and respiratory syndrome virus (PRRSv) subunit vaccine, PRRSV-RS (Sirrah-Bios, Ames, IA), on mortality rate and finisher pig growth performance in a PRRSV-positive commercial herd. Pigs were randomly assigned by litter to either subunit PRRSV vaccine or non-vaccinated control. Pigs in the vaccine group received an intramuscular injection of 1 mL PRRSV-RS vaccine at processing and weaning (approximately 4 d after birth and 24 d of age, respectively). Vaccine and control pigs were comingled in a single nursery. In the finishing phase, pigs were penned in a single commercial curtain-sided barn by treatment and gender (12 pens per treatment except for vaccinated barrows with 13 pens), with treatments randomly distributed across pens. Mortality was tracked from processing (4 d of age) to market (d 187 to 193). There was no difference between controls and vaccines for cumulative mortality (21.5 vs. 20.6%, $P = 0.67$) or for mortality during any production phase (processing to weaning: 9.5 vs. 7.1%, $P = 0.08$; nursery phase: 9.3 vs. 9.2%, $P = 0.95$; finishing phase: 4.4 vs. 5.9%, $P = 0.20$). Pens of pigs were weighed 2-wk post-placement into

the finisher (d 0). At that time, control and vaccinated mean pig weights were not different (26.5 ± 0.79 vs. 26.6 ± 0.77 kg, $P = 0.90$). Overall, there were no gender \times vaccine interactions ($P > 0.22$) for ADG, ADFI or G:F. From d 0 to 112, control and vaccinate pig performance was similar (ADG: 0.89 ± 0.012 vs. 0.87 ± 0.012 kg, $P = 0.45$; ADFI: 2.43 ± 0.037 vs. 2.43 ± 0.036 kg, $P = 0.94$; G:F: 0.37 ± 0.003 vs. 0.36 ± 0.003 , $P = 0.15$). This resulted in no difference ($P = 0.79$) in off-test (d 112) weights between control (123.3 ± 1.75 kg) and vaccinated (122.7 ± 1.72 kg) pigs. These data indicate that this subunit PRRSv vaccine did not affect finishing pig performance or mortality in this commercial herd.

Key Words: pig, PRRSv, vaccine

13 Effects of porcine circovirus type 2 (PCV2) and *Mycoplasma hyopneumoniae* (*M. hyo*) vaccine strategy and gender on commercial pig performance and carcass characteristics. J. R. Bergstrom¹, M. L. Potter^{*1}, M. D. Tokach¹, S. C. Henry², S. S. Dritz¹, J. L. Nelssen¹, R. D. Goodband¹, and J. M. DeRouchey¹, ¹Kansas State University, Manhattan, ²Abilene Animal Hospital, P.A., Abilene, Kansas.

A total of 1,993 pigs (7.4 kg and 25 d of age) were used to evaluate the effects of PCV2 and *M. hyo* vaccine strategies on performance and carcass characteristics. Vaccine strategies were: 1) 1 mL of CircoFLEX and 1 mL MycoFLEX (BI; Boehringer Ingelheim, St. Joseph, MO), administered together or 2) 2 mL Circumvent PCV and 1 mL Myco Silencer ONCE (IN; Intervet/Schering-Plough Animal Health, Millsboro, DE) administered as separate injections twice. Pigs, farrowed over 3-wk, were ranked by birth weight within litter and gender then randomly allotted to vaccine treatments. Pigs were vaccinated according to label at weaning (BI and IN) and d 22 (IN only). Individual pigs were weighed at weaning, d 22, 44, entry to finisher (Avg d 73), and off-test (Avg d 155) to measure ADG. Carcass data was obtained from a subsample of pigs. Data were analyzed with main effects of vaccine, gender, and their interaction with litter as a random effect. There were no vaccine \times gender interactions ($P > 0.05$) for any responses. Overall ADG was greater ($P < 0.01$) for barrows than gilts (761 vs. 693 g) resulting in barrows weighing 10.8 kg more at off-test than gilts. After HCW adjustment, gilts were leaner (53.3 vs. 51.8%; $P < 0.01$) than barrows. During the nursery phase, IN-vaccinated pigs had decreased (564 vs. 578 g; $P < 0.01$) ADG compared with BI-vaccinated pigs with the largest negative effect after the second dose of IN vaccines (d 22 to 44: 618 vs. 651 g, $P < 0.01$). Finishing ADG was increased ($P = 0.04$) for IN-vaccinated pigs (871 g) compared with BI-vaccinated pigs (858 g). As a result, there was no difference ($P > 0.13$) in overall ADG, off-test weights (BI: 120.5 kg; IN: 120.2 kg), or HCW-adjusted lean percentage (BI: 52.6%, IN: 52.5%) between vaccine strategies. Wean-to-finish mortality rate was not affected (BI: 3.9%, IN: 3.3%, $P = 0.49$) by vaccine strategy. Although IN vaccines reduced nursery pig performance, vaccine type did not affect overall performance or carcass characteristics.

Key Words: growth, PCV2, vaccine

14 Influence of halothane sensitivity on growth and meat quality in pigs. R. O. Bates^{*}, M. E. Doumit, N. E. Raney, E. E. Helman, and C. W. Ernst, Michigan State University, East Lansing.

We have previously reported that a proportion of pigs, homozygous normal for HAL1843, were halothane sensitive and this was associated with poor meat quality when pigs were handled aggressively. This study was conducted to evaluate halothane sensitivity in HAL1843 normal pigs, and ascertain the association of halothane sensitivity with ADG

and meat quality. A total of 363 pigs across four farrowing groups (REP), from seven Landrace sires and 38 Yorkshire-Landrace F1 dams, were tested at nine wk of age for halothane sensitivity using a closed system that delivered 5% halothane at 2 L/min for three (group 1) or two (groups 2-4) min. After 1 min limb rigidity (RIGID) was evaluated on a 1-4 scale, and limb tremors (TREM) and mid-section discoloration (MSD) were evaluated on a 1-3 scale with 1 indicating no reaction. Testing was repeated two days later. At 10 wk of age, pigs were moved to finishing pens and not moved again until marketing. Within REP, pigs were harvested in one of two groups and at marketing moved 91 m, weighed, tattooed, loaded and transported 550 km to a commercial harvest plant. After overnight rest pigs were harvested and loin muscle pH taken at 45 min (pH45) after stun. After an 18 hr chill, loin muscle pH (pHu), CIE L*, a*, b*, color (1-6) and marbling (1-10) scores and fluid loss percent (FLP) were collected. Generalized linear mixed models were used to estimate repeatabilities (REPEAT). On the binomial scale, REPEAT for RIGID for the front right and left legs were 0.24 and 0.31, respectively, while rear right and left leg REPEAT were 0.19 and 0.17, respectively. The REPEAT for front right and left leg TREM were 0.16 and 0.20, respectively. The ADG was not influenced by incidence of RIGID, TREM or MSD. Carcasses from pigs with RIGID scores of 1 vs those with higher scores had higher pH45 (5.97 vs 5.88; $P < 0.06$), similar pHu (5.47 vs 5.49; $P = 0.32$), lower FLP (4.6 vs 5.0; $P < 0.07$) and lower color score (2.08 vs 2.40; $P = 0.10$). Pigs exhibiting limb rigidity during halothane challenge had lower pH45 and higher fluid loss.

Key Words: pig, halothane, meat quality

15 (Invited ASAS Animal Science Young Scholar) Effects of diet on behavioral and neurophysiological indicators of aggression in pigs. R. Poletto^{*1,2}, B. T. Richert¹, R. L. Meisel³, H. W. Cheng², and J. N. Marchant-Forde², ¹Purdue University, West Lafayette, IN, ²USDA Livestock Behavior Research Unit, West Lafayette, IN, ³University of Minnesota, Minneapolis.

Aggression can affect health, well-being, and profitability of pigs. Feeding ractopamine (RAC), a β -adrenoreceptor agonist, enhances growth but may heighten aggression. In contrast, tryptophan (TRP), the precursor for serotonin (5-HT), may lessen aggressive behavior in pigs. To test these hypotheses, we investigated behavioral and neurophysiological variables related to aggression. In study 1, 64 finishing pigs (16 pens/sex) were fed control (CTL) or RAC (5 mg/kg for 2 wk, then 10 mg/kg for 2 wk). Behaviors were evaluated, and blood and brain samples were analyzed with HPLC for catecholamines and 5-HT. Feeding RAC raised behavioral activity compared to CTL fed pigs (26.1 vs. 22.2 0.9%, $P < 0.01$). Gilts fed RAC had an increase in fight actions (54.9%) while actions decreased in CTL barrows (44.0%), CTL gilts (24.4%), and RAC barrows (10.0%, $P < 0.05$); all subgroups engaged in fewer fights ($P > 0.10$). Regardless of dietary treatment, gilts' blood 5-HT was lower than barrows (2.4 vs. 2.0 ± 0.1 $\mu\text{g/mL}$, $P = 0.09$). Levels of 5-HT and its metabolite were lower in the brain of gilts and RAC-fed gilts, respectively, ($P < 0.05$). Expression of 5-HT1B receptor gene was suppressed in amygdala of gilts compared to barrows, which showed an over-expression of the gene (-1.3 vs. 1.1 fold, $P < 0.05$). In study 2, 48 gilts (6/pen) were fed CTL or high-TRP (250% of CTL) diet for 6 d at 3 and 6 mo with social handling from 45 d to 6 mo. Behaviors were evaluated and blood samples were analyzed for TRP and 5-HT. High-TRP feeding raised blood TRP of gilts at both ages (3 mo. 180.7%, and 6 mo. 85.2%) and raised blood 5-HT in 3 mo. old gilts (20.3%) when compared to baseline measures ($P < 0.05$). The TRP enhanced diet also reduced total fights (14.8 vs. 22.8 ± 3.0 , $P < 0.05$),

and increased latency to attack (114.1 vs. 62.5 ± 9.9 s, $P < 0.05$) in 3 mo old gilts compared to CTL. These outcomes are likely mediated by TRP stimulation of brain serotonergic system. Serotonergic deficiency may be related to aggression in gilts and integration of high-TRP with RAC feeding has the potential to reduce this behavior. Linking behavioral to neurophysiological indicators is a valuable approach, and their association with production practices can assist in improving pig productivity and well-being.

Key Words: swine, diet, aggression

16 A comparative study of lateral toe growth for sows housed in individual gestation stalls. A. K. Johnson^{*1}, A. M. Meiszberg¹, L. I. Engblom¹, K. J. Stalder¹, and L. A. Karriker², ¹*Iowa State University, Ames*, ²*Iowa State University, Ames*.

Sow removal is too high, occurs too early and is costly for commercial pork producers. The objectives of this study were to determine lateral toe growth rate of sows from different genetic lines and parities when housed in gestation stalls during a one month period. Thirty sows were used (Yorkshire [$n = 3$], Duroc [$n = 14$] and Yorkshire \times Duroc crosses [$n = 13$]). There were 10 parity one sows (158.8 kg to 204.1 kg), 10 parity two sows (181.4 to 226.8 kg), and 10 parity three sows (204.1 to 249.5 kg) respectively. Sows were individually housed in gestation stalls that had concrete flooring and deep pit manure storage. Lateral toe growth was collected once a week by a single observer. Data were analyzed as repeated measures, using sow as the subject, using the PROC MIXED procedure of SAS. Average hoof growth was 1.2 mm per week (range between lateral toes was 0.3 to 2.0 mm). The effect of foot pairs ($P = 0.65$) and side ($P = 0.39$) within sow were not different for lateral toe growth. Growth rate for front lateral toe pairs was 1.0 ± 0.03 mm and the rear lateral toes was 1.0 ± 0.04 mm. Growth rate for the left lateral toe pairs was 1.0 ± 0.04 mm and for the right lateral toes was 1.0 ± 0.03 mm respectively. Significant sources of variation for hoof growth were parity ($P < 0.001$), breed ($P < 0.001$) and week ($P = 0.03$). Toes from parity two sows grew quickest (1.26 ± 0.04 mm), parity three the slowest (0.78 ± 0.05 mm) and parity one were intermittent (1.03 ± 0.04 mm). Toes from Yorkshire sows grew slower (0.71 ± 0.06 mm) than Duroc and Crossbred (1.16 ± 0.04 and 1.2 ± 0.04 mm) sows. In conclusion, parity two sows had an accelerated rate of lateral toe growth and therefore, swine caretakers and veterinarians should be paying close attention to toe integrity when sows are in their second parity.

Key Words: breed, parity, toe-growth

17 Controlling aggression among gestating sows. Y. Z. Li, C. E. Phillips^{*}, S. K. Baidoo, and L. J. Johnston, *University of Minnesota, St. Paul*.

The objective of this study was to determine the effects of supplemental dietary Trp on aggression, social stress, and reproductive performance in group-housed gestating sows. Multiparous sows ($n = 168$) were mixed at weaning after 3 wks in farrowing stalls and were group-housed in 8 pens (21 sows/pen) equipped with totally slatted concrete floors and an electronic sow feeder (ESF). Sows were divided into 2 experimental treatments (4 pens/treatment). Control sows received corn-soybean meal based diets formulated to NRC requirements throughout gesta-

tion (0.15% Trp) and lactation (0.2% Trp). Three days before and after mixing, treated sows received diets containing twice the required Trp during gestation (0.3% Trp) and lactation (0.4% Trp). Six focal sows in each pen were identified and videotaped for 72 h after mixing to determine the number and type of aggressive interactions among sows. Before and 48 h after mixing, scratches resulting from aggression were assessed on all sows, and saliva samples were collected from the focal sows for cortisol analysis. Data were analyzed with Proc Glimmix of SAS with dietary treatment as the fixed effect and pen as a random effect. Supplementation of dietary Trp reduced total duration of head-to-head knocking (4.9 vs. 8.6 s/sow/h, SE = 0.96 ; $P < 0.01$) and tended to reduce the frequency of this aggressive behavior (1.2 vs. 1.9 times/sow/h, SE = 0.27 ; $P = 0.07$). Increased dietary Trp did not affect other aggressive behaviors, including head-to-body knocking and parallel pressing. There were no differences in injury scores or salivary cortisol concentrations between treatments. Sows fed high Trp diets farrowed more total piglets (12.6 vs. 10.5 piglets/litter, SE = 0.54 ; $P < 0.01$), and more live piglets (10.9 vs. 9.7 piglets/litter, SE = 0.44 ; $P < 0.05$) than sows in the control group. These results indicate that supplementation of dietary Trp at twice NRC recommendations for 3 days before and after mixing did not effectively reduce mixing-induced aggression and associated stress in gestating sows.

Key Words: sows, tryptophan, aggression

18 Effects of increased hutch ventilation on dairy calf performance. L. M. Pezzanite^{*1}, T. S. Dennis¹, R. C. Schroer¹, M. M. Schutz¹, S. D. Eicher², and T. D. Nennich¹, ¹*Purdue University, West Lafayette, IN*, ²*USDA-ARS, West Lafayette, IN*.

Heat stress can negatively affect the performance of dairy calves. Simple management strategies, such as increased ventilation of calf hutches, may assist with alleviating heat stress in dairy calves. The objective of this study was to determine if raising the back of calf hutches to increase ventilation during summer months had an effect on dairy calf performance. Thirty Holstein heifer calves (BW = 42.2 ± 16.0 kg) were moved to calf hutches with outside pens 2 to 3 d after birth and reared according to the protocols of the Purdue Dairy Research and Education Center. Hutches were bedded with wood shavings. Calves had ad libitum access to calf starter and water and received 2 L of milk replacer twice/d. Calves were blocked in groups of two and randomly assigned to one of two treatments: DOWN, with the back of the hutch on the ground, or UP, with the back of the hutch raised 20 cm. Upon assignment to treatment, calves were measured at 0800 hrs to determine BW, hip height (HH), wither height (WH), heart girth circumference, and rectal body temperature (TEMP). Measurements were repeated at 2, 4, and 6 wks after assignment to treatment. Respiration rate (RESP) and TEMP were determined twice/wk at 1400 h. Data were analyzed as repeated records using mixed models. Calves on treatments had similar ADG, HH gains, and WH gains (0.46 kg/d, 0.19 cm/d and 0.17 cm/d, respectively). Similarly, heart girth circumference and morning TEMP did not differ between treatments. Afternoon air temperatures during the study averaged 25.2°C and ranged from 16.1 to 30.0°C . Respiration rates (65.7 breaths/min) and afternoon TEMP (38.9°C) were similar between treatments. Raising the back of calf hutches to increase ventilation did not improve calf performance in mild summer temperatures.

Key Words: dairy calves, hutch, heat stress

19 Effect of lactation housing on growth performance of pigs. Y. Z. Li*¹, L. J. Johnston¹, and J. E. Anderson², ¹University of Minnesota, St. Paul, ²University of Minnesota, Morris.

A study was conducted to compare growth performance of pigs born in group-lactation housing with that of pigs born in farrowing crates. In group-lactation, pigs were farrowed in straw-bedded individual pens; mingled into groups of 8 litters at d 10; weaned at wk 5; and remained in the same group until wk 8 (72 pigs/group). Pigs born in crates were mixed and moved to pens of 9 pigs in a confinement nursery barn at weaning (wk 5). At wk 8, 108 pigs from each barn were selected based on sex, familiarity, and weight. Each 9 pigs (3 from each pen or room within each barn; 4 barrows and 5 gilts) were allocated to one of 24 pens in a confinement grow-finish barn, and remained there until wk 22. Pigs in both groups had ad libitum access to standard diets between wk 5 and wk 22. In each housing system, room temperatures were controlled to the thermal neutral zones. Body weights were recorded at birth, wk 5, wk 8, and every 2-wk thereafter until wk 22. Feed intake was monitored every 2 wk between wk 8 and wk 22. Data were analyzed using the MIXED procedure of SAS with repeated measures. Lactation housing was a fixed effect while pen served as a random effect. Compared with pigs from crates, pigs from group-lactation had greater ADG during the lactation (308 vs. 275 g, SE = 4.4; $P < 0.01$) and nursery (555 vs. 432 g, SE = 5.3; $P < 0.01$) periods, and were heavier at weaning (11.7 vs. 10.6 kg, SE = 0.16; $P < 0.01$), wk 8 (25.0 vs. 21.0 kg, SE = 0.13; $P < 0.01$), and wk 22 (106.9 vs. 103.0 kg, SE = 0.59; $P < 0.01$). After wk 8, ADFI of pigs from group-lactation was lower (2,004 vs. 2,188 g, SE = 42.5; $P < 0.05$) than pigs from crates. The low ADFI did not affect ADG (833 vs. 826 g, SE = 21.8), resulting in greater gain to feed ratio (0.431 vs. 0.393, SE = 0.0078; $P < 0.01$) for pigs derived from group-lactation compared with pigs from crates. The results indicate that pigs born in a straw-bedded group-lactation system grew faster during the lactation and nursery periods, and displayed improved feed efficiency during the growing-finishing period compared with pigs born in farrowing crates.

Key Words: group-lactation, pigs, growth performance

20 Association between sow longevity and gestation housing systems. L. Anil*¹, S. S. Anil², S. K. Baidoo¹, and R. B. A. Dahlen¹, ¹University of Minnesota, Waseca, ²University of Minnesota, St. Paul.

Sow longevity has economic and welfare implications. Housing system is one of the factors affecting sow longevity. Group housing systems are associated with increased aggression and consequent injuries and lameness affecting sow longevity. It is important to study the effect of housing systems on sow longevity given the current industry trend to move towards group housing systems. Similarities in genetics, feeding and management are essential for comparison of housing systems for sow longevity. The University of Minnesota has both individual gestation stalls (200 cm × 60 cm) and group pens (12.75 m × 6.75 m) with electronic sow feeders. This study compared the longevity of sows housed in stalls and in pens during gestation using a time to event analysis. The removal reasons in two housing systems were compared using 2-sample proportion test. A total of 712 (382 in pens and 330 in stalls) sows that farrowed for the first time during Jan 2004 to Dec 2006 were included in the study. These sows were followed for 750 d post-farrowing. The survivability of the sows housed in the two systems was compared

(Kaplan-Meier curves). The test of equality over strata (Log-rank test) indicated no difference in the survivor function of the two groups (Chi-squared = 0.3297, $P = 0.57$). Approximately 93% of the sows in both housing systems survived at 150 d post farrowing, but were reduced to 57 and 58% in the pens and stalls, respectively by d 750 after the first farrowing. The removal reasons varied in the two housing systems. The proportion of sows removed for lameness was higher ($P < 0.05$) among those sows removed from the pens (32%) compared to the stalls (8%). The proportion of sows removed for other reasons was lower ($P < 0.05$) in the pens (18%) compared to the stalls (34%). The proportion of sows removed for reproductive problems tended to be higher ($P = 0.07$) in the stalls (58%) compared to pens (51%). Although the overall longevity is similar in both systems, the study indicated a higher proportion of removals due to lameness in group housed sows. This appears to be an important issue given the industry move to housing system change is driven by welfare concerns associated with gestation housing.

Key Words: sow, welfare, longevity

21 Analysis of the association between the number of lesions in different claw areas in sows. S. S. Anil*¹, L. Anil², J. Deen¹, S. K. Baidoo², M. E. Wilson³, and T. L. Ward³, ¹University of Minnesota, St Paul, ²University of Minnesota, Waseca, MN, ³Zinpro Corporation, Eden Prairie, MN.

The pathway in the development of claw lesions in pigs is not well understood. The occurrence of lesions in different claw areas (heel, sole, heel-sole junction, white line and side wall) is difficult to be explained as caused by the physical properties of the floor or by the interaction between the floor surface and claw horn alone. Predisposing factor(s) may exist for the development of claw lesions. Knowing whether different claw lesions are independent of each other will help to develop this hypothesis further. The objective of this study conducted at the research station of the University of Minnesota was to analyze the correlations (Spearman rank correlation, SAS v 9.1) between the numbers of lesions in different claw areas (in lateral and medial claws and in front and hind limbs) of 229 sows housed in conventional gestation stalls. The sows were examined between d 60-70 of gestation. The total lesions ranged from 0-16. The percentage of sows with no lesion was 1.7. Positive correlations ($P < 0.05$) were observed between the total number of lesions in lateral and medial claws, total number of lesions in hind and fore limbs, long claws and long dew claws ($r = 0.2$ for all), heel lesions and overgrown heels ($r = 0.5$), heel lesions and vertical side wall cracks, heel-sole junction lesions and vertical side wall cracks ($r = 0.2$ for both), white line lesions and sole lesions ($r = 0.14$), horizontal side wall cracks and sole lesions, and vertical side wall cracks and sole lesions ($r = 0.17$ for both). Heel-sole junction lesions were negatively correlated with $P < 0.05$ long claws and long dew claws ($r = -0.13$ for both). Analyses indicated that claw lesions are not independent in occurrence. Significant correlation between long claws and long dew claws may be indicative of a systemic defect in claw horn growth. This may also partially support a diet/hormone induced change in the laminae of the hoof horn as suggested in dairy cattle. The higher possibility of injuries to overgrown heel may explain the positive relationship between heel lesions and overgrown heels. The other relationships observed may have a biomechanical basis warranting further studies.

Key Words: claw lesions, lesion type, sows

22 Analysis of the association of environmental temperature and relative humidity with the severity of claw lesions in sows. S. S. Anil^{*1}, L. Anil², J. Deen¹, S. K. Baidoo², M. E. Wilson³, and T. L. Ward³, ¹University of Minnesota, St Paul, ²University of Minnesota, Waseca, ³Zinpro Corporation, Eden Prairie, MN.

Housing system is important in the development of claw lesions in pigs. Environmental factors such as temperature and relative humidity are also related to claw lesions in pigs. The objective of the present study, conducted at SROC, Waseca was to analyze the association between the severity of claw lesions in gestating sows housed in conventional gestation stalls (233) and in group pens with electronic sow feeder (304), and air temperature and relative humidity. These sows were included from different farrowing batches (stall-housed sows: August-December 2008 and group-housed sows: September 2007 to October 2008). The claws of these sows were examined between d 60-70 of gestation and lesions were scored using Zinpro FeetFirst lesion scoring system. The total lesion scores in groups and stalls ranged from 5-24 and 0-25, respectively. Daily data on air temperature and relative humidity for Waseca for the period from September 2007 to December 2008 were collected from the weather station at Waseca Municipal airport. The association of total claw lesion scores with the average values for air temperature and relative humidity for 14 d prior to the date of claw lesion scoring was analyzed using Spearman partial correlation, controlling for housing system (Proc corr, SAS V 9.1). Overall, the correlations were small. The partial correlation coefficient between total score and temperature was -0.15 ($P < 0.05$) and that between total score and relative humidity was 0.03 ($P = 0.5$). The respective ordinary Spearman correlation coefficients were -0.23 ($P < 0.05$) and 0.01 ($P = 0.7$). The partial correlation between temperature and relative humidity (-0.57) was also significant ($P < 0.05$). The lower value of the partial correlation coefficient for total score and temperature confirms the role of housing system in the relationship between lesion scores and temperature. Studies in dairy cattle have suggested higher incidence of lesions with an increase in moisture content of claw. The observed negative relationship between temperature and lesion score could be due to the negative relationship between temperature and relative humidity.

Key Words: claw lesions, temperature, humidity

23 Survey of the incidence and causes of pre-weaning mortality (PWM) and evaluation of the effect of colostrum supplementation on pre-weaning survival. J. W. Charal^{*1}, M. Ellis¹, A. M. Gaines², B. A. Peterson², B.F. Wolter², and R. Bowman², ¹University of Illinois, Urbana, ²The Maschhoffs, Carlyle, IL.

The objective of this research was to establish the timing and causes of PWM and, also, to evaluate the effect of colostrum supplementation of neonatal piglets on PWM. A survey of 612 litters born over a 2-mo period was carried out in a commercial facility; the timing and cause of death and piglet weights at birth and weaning were recorded. A total of 808 piglets (10.8% of piglets born alive) died during the survey. The major causes of PWM were crushing (76.9%), starvation (11.1%), and low viability at birth (3.0%); the majority of mortality occurred in the first week after birth (52.1% by d 2 and 77.6% by d 7 post-farrowing). A large proportion (37.0%) of the piglets that died had empty stomachs. The rates of stillborn, and low viability piglets and PWM decreased with increasing birth weight; for piglets with birth weights < 1 kg compared to

> 1 kg, rates for stillborn were 11.5 and 3.3%, respectively; low viability piglets were 22.0 and 0.03%, respectively; and total PWM were 27.3 and 9.1%, respectively. For the colostrum study, 300 low birth weight (< 1.20 kg) piglets were used in a randomized complete block design (block = sow) with 3 treatments: 1) Control (CO; no supplement); 2) Artificial colostrum (AC; 2cc ~24 h post-farrowing); 3) Natural colostrum (NC; 20cc ~24 h post-farrowing). Cross-fostering was carried out such that sows only suckled study piglets and all 3 treatments were equally represented on each sow. Supplementing with NC tended ($P = 0.10$) to reduce mortality levels to 3d post-farrowing (5.0, 10.0, and 15.0% for NC, AC, and CO, respectively; SEM 3.0) but there was no treatment effect on PWM (22.0, 14.0, and 23.0%, respectively; SEM 5.4) or on piglet weight at weaning (4.84, 4.91, and 5.02 kg, respectively; SEM 0.163). This study confirms that birth weight is a major factor in PWM and suggests that colostrum supplementation did not reduce PWM in light birth weight piglets.

Key Words: pre-weaning mortality, colostrum, birth weight

24 Grazing behavior of heifers measured by handheld GPS. F. Lopes^{*1}, D. K. Combs¹, P. C. Hoffman¹, N. M. Esser¹, and W. Coblenz², ¹University of Wisconsin, Madison, ²USDA/ARS, Marshfield, WI.

The objective of this study was to assess how previous grazing experience affects animal movement on pasture. Portable GPS units were used to monitor movements of 32 Holstein ($n = 21$) and Holstein-Jersey ($n = 11$) yearlings. Total distance walked was measured and analyzed as a randomized complete block experimental design. Two heifer groups ($n = 8$ per group) had been exposed to pasture from August through October 2008, while the other two groups had been continuously housed in a bedding pack barn since weaning. All 4 groups were housed in the same bedding pack barn from November 2008 until the start of the experiment. In June 2009, the four groups of heifers were assigned to one of 4 Italian ryegrass pastures, thus, the experimental unit was paddock. Each pasture was 1.73 ha and was divided in half with a cross wire. Each group was allocated approximately 50 kg pasture DM/head initially. Portable GPS units (Trackstick) were attached to neck collars on each heifer at 0600 hr for the first 5 consecutive mornings that the heifers were turned on the pastures. The GPS units recorded the location of each heifer at one minute intervals for the next eight hours. Heifers were then returned to the barn, the GPS units removed and the heifers remained in the barn until the next morning. Movements of heifers that had grazed in 2008 differed from those with no previous grazing experience. The heifers with grazing experience walked further (5.49 vs. 3.56 km, $P < 0.05$) than heifers that had no prior grazing experience during the first two days. By the third day of the experiment, distances traveled were similar for both groups. After the first week of grazing, heifers remained on the pastures continuously and movements were monitored by the GPS units every two weeks through August, 2009 (7 periods, 2 consecutive days per period). In subsequent recording periods the distance traveled per eight hours was less than recorded during the first week (3.57 vs. 2.30 km, $P < 0.05$) and did not differ between groups. The data suggest that prior grazing experience initially affected animal movement on pasture; however, movement pattern was similar after adaptation perhaps from learned behavior acquisition.

Key Words: grazing, behavior, heifers

25 Predictors of thermal status during critical periods of gestation, lactation, and post-weaning in primiparous sows. E. A. Coate*, M. C. Lucy, T. J. Safranski, P. A. Eichen, A. M. Williams, and D. E. Spiers, *University of Missouri, Columbia*.

Heat stress affects the thermal status of sows during gestation, lactation, and post-weaning periods, with lactation being the more sensitive. Thermal status determines heat strain level and impact on productivity. The present study used primiparous sows (n=22) to identify reliable predictors of thermal status. They were housed beginning the last 3 weeks of gestation in environmental chambers (Brody Environmental Center; University of Missouri), and maintained in this facility through farrowing, lactation, and post-weaning periods. Thermal conditions were either thermoneutral (17.5 to 19.3 °C; TN) or heat stress (23.8 to 30.9 °C). Air temperature (Ta) and humidity were recorded hourly, with daily physiological measurements at 0800, 1200, 1600, and 2000. Measurements included respiration rate, and rectal (Tre) and skin temperatures (tail, rump, shoulder, and ear). Analyzed periods were averages of 4-5 days that included

late gestation, lactation and early post-weaning periods. Third-order polynomial regression analysis was used to determine significant predictors ($P < 0.05$) based on R-squared values. Results across all periods showed that skin temperatures were highly correlated with each other and Ta. Also, skin temperatures were significant predictors ($P < 0.05$) of respiration rate, with extremity (ear and tail) and trunk (shoulder and rump) sites being equally reliable. Averages of extremity, trunk, or all skin sites combined did not improve predictions. Respiration rate and Tre were poorly correlated throughout all periods. In addition, prediction of Tre was nearly half that for respiration rate using skin temperatures. Correlation of Ta with prediction of respiration rate or Tre ranked less than for skin temperatures across all periods. Skin temperature at individual sites is the best predictor of respiration rate and rectal temperature for the heat-stressed sow during critical periods of reproduction, with respiration rate being the more sensitive indicator of thermal strain.

Key Words: heat, stress, prediction

Billy N. Day Symposium

26 (Invited) The physiologic response to stress and its effects on swine reproduction. D. C. Lay Jr.*, *ARS-USDA, West Lafayette, IN*.

When exposed to a stressor swine invoke behavioral and physiologic responses which are designed to enable the individual to cope with the negative effects of the stressor. The activity of the hypothalamic-pituitary-adrenal axis is increased resulting in elevated corticotropin-releasing factor (CRF), adrenocorticotropic hormone (ACTH) and glucocorticoids. Similarly the sympatho-adrenal axis is activated resulting in an increase in epinephrine. The extent to which these systems are activated depends on both the duration and intensity of the stressor. The animal's current disposition, for instance its nutritional state, health state, and level of arousal can also influence the extent to which the stressor may cause damaging effects. Whether the activation of the stress response in pigs influences measures of reproductive success depends on many factors, including: application of the timing of the stressor, intensity and type of the stressor, the animal's stage of reproduction when exposed to the stressor, the animal's genetic predisposition to stress susceptibility, and previous experiences of the animal. It is also known that short-term stress can have an enhancing effect on reproduction while chronic stress is typically inhibitory of reproductive success. It is also important to note that a significant body of literature is contradictory, with some indicating that stress has little effect on swine reproduction. This presentation will review the current state of knowledge relative to the effects of stress on swine reproductive ability while focusing on the endocrinological events associated with the stress response and failure or success of reproductive function in swine.

Key Words: swine, reproduction, stress

27 (Invited) Use of *Artemisia* sp. to alleviate heat stress induced male infertility. W.R. Lamberson^{*1}, H. Smith¹, K. M. Cammack², and T.J. Safranski¹, ¹*University of Missouri, Columbia*, ²*University of Wyoming, Laramie*.

Exposure to high ambient temperatures reduces reproductive performance in boars and males of other species, including humans, through compromised spermatogenesis. There is a genetic component to heat tolerance although the heritability of male fertility during heat stress is low (0.14 in mice), indicating that environmental factors have a major influence. *Artemisia afra* is an herb used to alleviate heat stress during

desert travel by indigenous peoples of South Africa. The objective of this experiment was to determine the effect of treatment with *Artemisia afra* (AF) or the related plant *Artemisia absinthium* (AB) on heat-stress induced male infertility in mice. Decoctions of AF and AB were prepared by boiling whole ground plant (2 mm screen; 1% wt:vol) in water for five min and subsequently filtering out solids. Ten male ICR mice per treatment were given AF, AB or tap water (HSC) for 5d before and during a 24 h period at 35°, or no treatment at 21°C (C) and mated to eight ICR females from d 18 to 28 post heat stress. Females were sacrificed on d 18 post mating and ovulations, implantations and fetuses were counted. Treatment with AF or AB resulted in increased daily fluid intake, prenatal survival, and activity (measured as movement counts) compared to HSC ($P < 0.01$ for all), with no differences among heat stress groups in body temperature. These results suggest that pretreatment with *Artemisia* sp. is effective in reducing infertility associated with heat stress through an unknown mechanism of action unrelated to core body temperature.

Table 1. Least squares means of response variables by treatment.

Group	Body Temp (°C)	Fluid Intake (mL)	Activity	Prenatal Survival
AB	39.3 ^a	20.5 ^e	118.3 ^p	74.8% ^y
AF	39.6 ^a	20.5 ^e	121.4 ^p	76.0% ^y
HSC	39.3 ^a	18.4 ^f	39.0 ^r	56.1% ^z
C	36.5 ^b	14.2 ^g	78.9 ^q	84.5% ^x

Key Words: artemisia, heat stress, infertility

28 (Invited) Seasonal effects on sow herds: Industry experience and management strategies. D. S. Pollmann*, *Murphy-Brown LLC, Ames, IA*.

One of the most important components of successful sow operations is to be able to maintain consistent weekly weaned pig throughput and weaning weights. It is a well established production observation that sow productivity is dramatically affected due to breeds done during the summer months. It is common to observe a reduction in farrowing rate of 5 to 10% and litter size by 0.3 to 0.5 pig per female, especially evident during the months of November to January. Typical historical results will be presented illustrating the impact of summer fertility on productivity metrics. Methods and procedures (employee training, planning, inventory adjustments, semen handling, and facility improvements) to

compensate for expected lower fertility in swine will also be discussed. Operations that are effective in minimizing summer fertility challenges have a competitive advantage in productivity and cost control.

Key Words: sow performance, seasonal effects, sow management strategies

29 (Invited) Physiological and reproductive responses to periparturient heat stress in sows. T. J. Safranski*, A. M. Williams, and M. C. Lucy, *University of Missouri, Columbia.*

Productivity of sows is known to be affected by thermal environment, with impacts during gestation thought to be greatest early (embryonic mortality and returns to estrus) and late (fetal death and increased still-born rate). Lactational heat stress affects feed intake, milk production, piglet growth, sow body weight loss, and follicular growth, and results in delayed postweaning return to estrus or anestrus. The impact is mediated through both physiological and physical means. Temperatures above thermoneutral are known to reduce LH pulse frequency and amplitude as a result of reduced hypothalamic GnRH concentrations. Sows attempt to cope with elevated temperatures through increased respiration, decreased

feed intake, and shunting more blood to the skin, the latter of which may lead to restricted nutrient flow to placenta. Much of the literature is from sows with lower productivity, and perhaps lower metabolic rate, than modern high productivity sows. Recent work has investigated how elevated temperatures in late gestation interact with lactation thermal environment. Sows (58 primiparous) were housed at either thermoneutral (18-20 °C; TN) or heat stress (24-30 °C; HS) temperatures during the last two weeks of gestation. At day 110 of gestation half of each group moved to TN and the other half to HS farrowing rooms. Since sows were limit fed in gestation, no impact was observed on feed intake, though expected differences were measured in body temperatures. High temperatures in lactation, however, did reduce feed intake. Sows housed in HS gestation and TN lactation had lower lactation weight loss than TN-TN, TN-HS or HS-HS (22.2 ± 3.0 , 30.4 ± 3.0 , 32.6 ± 3.0 and 30.7 ± 3.0 kg, respectively), presumably adaptation or compensatory feed intake. Litter size differences (born alive or weaning) were not detected, but sows in TN lactation weaned heavier pigs (6.21 ± 0.23 vs. 5.76 ± 0.22 kg). Increasing our understanding of how sows cope with elevated temperatures and what can be done to help them will continue to be important with more highly productive sows.

Key Words: sow, heat stress, reproduction

Breeding and Genetics

30 Comparison of sire re-ranking from censored sow lifetime reproductive traits. L. Engblom*¹, K. Stalder¹, J. Holl², W. Herring², S. Tsurata³, M. Culbertson², and J. Mabry¹, ¹*Iowa State University, Ames*, ²*Smithfield Premium Genetics Group, Rose Hill, NC*, ³*University of Georgia, Athens.*

Although sow longevity is an important economic and animal well being trait, genetic evaluations are challenged for implementation due to the long time interval required to collect complete lifetime data and low reliability of early indicator traits. Programs handling censored records may provide an adequate alternative. This study applied two censoring capable software packages to lifetime born alive (LBA) data with 30% censoring. Data included 9868 pedigreed commercial F1 (LR×LW) sows with first farrowing between 2004 and 2009 on a single farm. Genetic solutions from Survival Kit 3.12 (LBA_S) and Gibbs2Cen, a Gibbs sampler (LBA_G; 5000 samples) were evaluated. In addition, LBA was analyzed in DMU6, by including complete records only (LBA_CR; n=6912) and by ignoring censoring (LBA_IC), as well as accumulated born alive in parities 1 to 5 ignoring censoring (BA1 to BA5). In DMU and Gibbs2cen, an animal model was fitted including the fixed effect of first farrowing year-month. In Survival Kit a sire model was fitted with the fixed time dependent effect of farrowing year-month. Heritabilities were estimated from 0.06 to 0.12. Spearman rank correlations were estimated between solution sets of 106 (LBA_CR; 86) sires, each with at least 30 F1 daughter records. Rank correlations with LBA_S are negative due to scale direction. All correlations were favorably significant ($P < 0.05$). Estimated sire rank correlations between LBA_S and solution sets from LBA_G, LBA_IC, LBA_CR, BA5, BA4, BA3, BA2, and BA1 were -0.74, -0.70, -0.63, -0.69, -0.65, -0.56, -0.43 and -0.22, respectively. Estimated sire rank correlations between LBA_G and solution sets from LBA_IC, LBA_CR, BA5, BA4, BA3, BA2, and BA1 were 0.99, 0.93, 0.96, 0.91, 0.78, 0.55 and 0.27 respectively. Estimated sire rank correlations between LBA_CR and solution sets from LBA_IC, BA5, BA4, BA3, BA2, and BA1 were 0.96, 0.93, 0.87, 0.71, 0.48 and 0.18, respectively. The results showed sire ranking for

LBA differs depending on which program is used and indicated that accumulated born alive in medium parities may be a good indicator for LBA and could be considered in breeding evaluations.

Key Words: sow, lifetime reproduction, sire rank

31 Lifetime reproductive traits in Landrace, Yorkshire and crossbred sows. L. Engblom*¹, C. Schwab², K. Stalder¹, and J. Mabry¹, ¹*Iowa State University, Ames*, ²*National Swine Registry, West Lafayette, IN.*

Sow longevity is an important economic and animal well-being trait which can be improved by selection for more robust animals. Selection is typically performed on nucleus herd purebred animals, but the longevity traits are truly expressed in crossbred sows in commercial herds. This study aims at investigating longevity traits at both levels, to determine how accuracy of selection in nucleus animals is influenced by incorporating data from the commercial level. Data consisted of 5,763 Landrace (L), 11,982 Yorkshire (Y) and 9,295 crossbred (F1; L×Y and Y×L) sows with first-parity farrowing records between 2001 and 2008. Statistical analyses were performed with DMU (AI REML), on complete records with five generations of pedigree information. The statistical model included farm and year as fixed effects and random effects of animal and contemporary group (3-month first parity farrowing period within herd). Lifetime born alive heritabilities were estimated from 0.07 to 0.12 and the corresponding figures for removal parity were 0.04 to 0.12. Heritability estimates of the binomial measure of stayability from parity 1 to 2, ranged from 0.02 to 0.08, while corresponding figures for stayability from parity 1 to 3 ranged from 0.02 to 0.09. Heritability estimates for accumulated number born alive up to parity 2 and 3 ranged from 0.08 to 0.09 and from 0.07 to 0.13, respectively. Analyzing stayability among F1 sows to parity 2 and 3 with a binomial distribution resulted in higher heritabilities (h^2 range: 0.07-0.15) than when fitting normal distribution (h^2 range: 0.02-0.03). Among F1 sows lifetime

born alive had an estimated genetic correlation to age at first farrowing at -0.59 , to stayability from parity 1 to 2 at 0.88 , to productive life at 0.71 , to removal parity at 0.94 and to life time number weaned at 0.91 . The range in genetic correlations between purebred and crossbred performance indicates that significant genetic by environment interactions exist for some traits and the use of crossbred information may increase the accuracy of genetic evaluation for longevity characters.

Key Words: sow, lifetime reproduction, breed

32 Associations of gilt leg soundness traits with sow lifetime reproduction. M. Nikkilä^{*1}, K. Stalder¹, B. Mote¹, J. Lampe², B. Thorn³, M. Rothschild¹, A. Johnson¹, L. Karriker¹, and T. Serenius¹, ¹Iowa State University, Ames, ²Swine Graphics Enterprises, Webster City, ³Newsham Choice Genetics, West Des Moines.

The objective of this study was to estimate the genetic parameters for leg soundness and lifetime reproductive traits. The study involved 1,447 females from two commercial genetic lines. Gilts averaged 124 ± 11 kg and 190 ± 7 d of age at soundness evaluation, which included front legs (legs turned, buck knees, pastern posture, foot size and uneven toes), rear legs (legs turned, weak/upright legs, pastern posture, foot size and uneven toes) and overall leg action. Evaluation was completed independently by two scorers using a nine-point scale. Reproductive traits included lifetime (L), percentage non-productive from total herd days (NPD%), lifetime number born alive (LBA) and number born alive per lifetime days (LBA/L). The DMU-package (AI-REML) was used to estimate variance components. The model for soundness traits had genetic line, evaluation day and scorer as fixed effects, animal as a random effect and weight at evaluation as a linear covariate. The model for reproductive traits included genetic line and herd entry group as fixed effects and animal as a random. Heritability estimates ranged from 0.07 to 0.29 for soundness traits and from 0.14 to 0.17 for reproductive traits. Most of the genetic correlations between soundness and reproductive traits were low and non-significant. However, slightly outwards turned front legs were significantly ($P < 0.05$) associated with greater LBA and LBA/L ($r_g = 0.59, 0.66$), less upright rear legs with greater LBA/L and lower NPD% ($r_g = -0.55, 0.58$) and smaller rear feet with greater L ($r_g = 0.51$). Results also implied that intermediate pastern posture would be associated with improvements in reproductive traits ($r_g = -0.47-0.59$). The genetic correlations of overall leg action with lifetime reproduction were unfavorable but non-significant ($r_g = -0.21-0.27$). The animals were preselected for the structural soundness by the genetic supplier, which is likely to bias these estimates. At the termination of data collection, 14% of females were alive. Analyses were implemented using Gibbs sampling procedures allowing incorporation of censored records. Preliminary results were similar to estimates obtained when ignoring censoring in DMU.

Key Words: gilt, leg soundness, lifetime reproduction

33 Association of single nucleotide polymorphism (SNP) markers in candidate genes and QTL regions with pork quality in commercial pigs. G. A. Rohrer^{*1}, D. J. Nonneman¹, R. K. Miller², H. Zerby³, and S. J. Moeller³, ¹USDA ARS, Clay Center, NE, ²Texas A&M University, College Station, ³The Ohio State University, Columbus.

Numerous reports have described genetic markers or genomic regions (QTL) associated with pork quality and/or palatability. Validation of these associations in other commercial populations is necessary before

these markers should be used. Therefore, we tested 130 SNP markers from 35 candidate genes and 8 QTL regions for association with pork quality and palatability traits from 888 pork loins. Loins were collected at three slaughter facilities and chosen to represent a wide range of pork color, pH and marbling. About half of the loins from one facility were enhanced. Objective and subjective measures of color and marbling were collected on each loin. Loins were aged 7 days and purge loss recorded. Frozen chops were thawed, purge loss recorded, cooked to 63, 68, 74 or 79°C internal temperature, and Warner-Bratzler shear force determined. Data were analyzed with SAS Proc GLM where the model included fixed effects of PLANT, DATE and marker genotype. Enhancement treatment was also included for purge loss. Thaw-purge loss data was analyzed with Proc MIXED where PLANT, DATE, enhancement and marker genotype were fitted as fixed effects and loin within marker genotype as a random effect. Shear force and cooking loss were analyzed similarly except cooking time; final temperature and thaw purge loss were included as covariates. Of the candidate genes tested, IGF2 was associated with multiple objective color parameters; MC4R with color, pH and marbling; CAST with shear force and PRKAG3 with measures of color, pH, purge and cooking loss. Six QTL regions were validated (SSC1:60-75 for color, SSC2:0-12 for color, pH and purge; SSC2:60-80 for shear force; SSC6:60-80 for color and pH; SSC15:44-60 for pH and purge loss; SSC17:30-45 for color and marbling). These results indicate these loin samples are quite valuable for marker validation and many of the associations could be useful for selection in commercial swine populations.

Key Words: markers, pork quality, association

34 Association of functional SNPs in pig calpastatin regulatory regions with tenderness. D. J. Nonneman^{*1}, A. K. Lindholm-Perry¹, S. D. Shackelford¹, D. A. King¹, T. L. Wheeler¹, G. A. Rohrer¹, C. D. Bierman², R. K. Miller³, H. Zerby⁴, and S. J. Moeller⁴, ¹USDA, ARS, Clay Center, NE, ²Babcock Genetics Inc., Rochester, MN, ³Texas A&M University, College Station, TX, ⁴The Ohio State University, Columbus.

The identification of predictive DNA markers for pork quality would allow U.S. pork producers and breeders to more quickly and efficiently select genetically superior animals for production of consistent, high quality meat. Genome scans have identified QTL for tenderness on pig chromosome 2 which have been fine-mapped to the calpastatin locus. The objectives of this study were to identify the causative sequence variation in calpastatin that likely affects tenderness in commercial-level pig populations and to develop definitive DNA markers that are predictive of pork tenderness for use in marker assisted selection programs. We resequenced the calpastatin regulatory and transcribed regions in pigs with divergently extreme shear force values in order to identify possible mutations that could affect tenderness. One hundred ninety-four single nucleotide polymorphisms (SNP) were identified in this sequence. We tested 130 polymorphisms in our research population and a subset (32) of these in samples of industry pigs for association with objective measures of tenderness. We identified five SNPs that were highly associated ($P < 0.000001$) with pork tenderness in all of the populations studied, representing 2,826 pigs from four distinct populations. Twenty-nine SNP were found in transcription factor binding sites and gel shift assays were designed for 16 polymorphic sites, including the five SNPs that were the most significant in all populations. Five polymorphic sites demonstrated binding to nuclear extracts in gel shift assays and four of these were allele-specific in their ability to bind nuclear proteins. These SNPs were not in complete linkage disequilibrium with each other and

may independently affect calpastatin expression. These markers should be predictive of pork tenderness in industry populations.

Key Words: pig, SNP, calpastatin

35 Estimates of genetic parameters of pig temperament scores during performance test. C. L. Yoder*¹, J. S. Fix¹, C. Maltecca¹, J. P. Cassady¹, S. Price², and M. T. See¹, ¹*North Carolina State University, Raleigh*, ²*Ivey Spring Creek Farms, Goldsboro, NC*.

Greater understanding of pig temperament may lead to improvements in pig well-being, handling, and production efficiency. The objective of this study was to estimate genetic parameters associated with temperament scores recorded during a performance test. Chester White (CW), Duroc (D), Landrace (L), and Yorkshire (Y) boars and gilts were scored individually (n= 1,076, 1,832, 941, 925, respectively) for three temperament scores; load score (LS), scale score (SS), and vocal score (VS). All temperament scores ranged from 1 (calm) to 5 (highly excited). While pigs were loaded onto a scale LS was recorded. Pigs were simultaneously evaluated for SS and VS while on the scale having real-time ultrasound images recorded. A pig's activity was measured by LS and SS. After phenotypic analysis it was determined VS consisted of two categories, vocal and non vocal, and was analyzed as a binary trait. All models included fixed effects of sex and contemporary group (barn-farm-test date), covariate of off-test weight and random effect of animal. For LS, order in which pigs were tested was included as a fixed effect. Variance components were estimated using THRGIBBS1F90 with 150,000 cycles, a 20,000 cycle burn in period, and every 10th sample was stored. Estimates of parameters of interest were obtained as statistics of their respective posterior distributions. Direct heritability estimates were (CW, D, L, Y): LS (0.05, 0.06, 0.06, 0.05), SS (0.22, 0.09, 0.09, 0.10), and VS (0.27, 0.24, 0.37, 0.21). Estimated heritability of LS was low regardless of breed and was discarded from further analysis. Heritability estimates for SS, while higher than LS, were low with the exception of CW. Heritability estimates for VS were moderate. Direct genetic correlations between SS and VS obtained in a bivariate model were positive and moderate (0.42, 0.75, 0.43, 0.30) indicating that pigs that are more active in the scale are also more vocal. Based on these results there is potential to alter pig behavior through selection for temperament scores collected during a performance test and pig vocalization would have the greatest response to selection.

Key Words: genetic parameters, pigs, temperament

36 A robust whole-genome analysis using Student's-t distribution for residuals. K Kizilkaya*^{1,2}, R. L. Fernando¹, and D Garrick¹, ¹*Iowa State University, Ames*, ²*Adnan Menderes University, Aydin, Turkey*.

Fitted linear models include explanatory variables and remainder or residual effects that are typically assumed to be normally distributed. Violation of this assumption can adversely affect results. A simulation study was conducted to quantify accuracy of genomic prediction assuming Student's-t distributions for residuals with varying degrees of freedom (df) that approach normality as df goes to ∞ . Predictive log-

likelihood (PLL) was used to discriminate goodness of fit for alternative models. A trait with heritability 50% determined by 50 or 500 QTL was generated for df=3 (heavy-tailed, H) or ∞ (normal, N) residuals. QTL were simulated by randomly selecting loci from 50k SNPs and assigning effects (β) from a normal distribution. Phenotypic values of 3,000 animals for the 50H, 50N, 500H, 500N simulations were generated by summing 50 or 500 QTL effects and adding simulated H or N residuals. Simulations were replicated 5 times. Estimation of SNP effects were from a Bayesian model averaging method fitting a mixture model that assumed most SNP (0.995 for 50 and 0.99 for 500 QTL) had zero effect on the trait. It was similar to Bayes-B, except with common variance for marker effects in the model assuming heavy-tailed with unknown df, or normal residuals. The heavy-tailed analysis had PLL higher (heavy tailed data) or equal (normal data) to the normal analysis. Posterior estimates of df were small with a peaked distribution (3.0-3.6) for heavy-tailed data or large with a flat distribution (>50) for normal data. Heavy-tailed analyses outperformed (ie had larger correlations between true and estimated genetic values) for heavy-tailed data for example 0.53 vs 0.47 for 50 QTL and 0.27 vs 0.25 for 500 QTL. Correlations decreased when QTL increased from 50 to 500.

Key Words: Student's-t model, genomic selection, Bayes-B

37 Environmental and genetic factors affecting bull sperm shape using Fourier harmonic analysis. M. F. Grunwald*, J. J. Parrish, and A. I. Saravia, *University of Wisconsin, Madison*.

Fourier harmonic amplitudes (FHA) have previously been shown to be an objective, repeatable, and accurate measure of sperm nuclear shape. Harmonic amplitudes 0-5 (HA0-HA5) are derived from FHA. The description of overall nuclear size comes from HA0, while HA1 describes the anterior head, HA2 the length of the sperm along the longitudinal axis, and HA3 to 5 the distal, post-nuclear curvature of the sperm head. Semen was cryopreserved from extensively used sibling and half-sibling Holstein bulls (n=138) of age .92 years to 13.25 years (7.41±1.94 years). Semen was provided from 12 artificial insemination organizations and evaluated for FHA. The semen was thawed briefly in 35°C water and incubated in 1.6 μ M Hoechst 33342. Sperm cells were then washed and fixed to slides and analyzed for head shape. Harmonic amplitude means \pm SD (microns) for all bulls are as follows: HA0 (3.083 \pm 0.100), HA1 (0.118 \pm 0.019), HA2 (1.100 \pm 0.064), HA3 (0.127 \pm 0.018), HA4 (0.227 \pm 0.037), HA5 (0.079 \pm 0.017), respectively. Heritabilities (%) of the harmonic amplitudes with residual and sire variances were estimated using the REML procedure applied to single-trait animal models on the average harmonic values for each bull and are as follows: HA0 (0.212, 92.15, 0.049), HA1 (2.253, 77.88, 0.441), HA2 (2.635, 69.83, 0.463), HA3 (0.627, 90.88, 0.143), HA4 (5.359, 55.316, 0.751), HA5 (3.630, 66.74, 0.611), respectively. While this indicates a low significance of FHA in determining breeding value, the error which is incorporated with the environmental factor is also typically low with this procedure. Being that low fertility and high fertility groups can be directly formed based on sperm shape in bulls and boars, it seems that the environmental factor is mostly responsible for this.

Key Words: heritability, Fourier harmonics, breeding value

David H. Baker Amino Acid Symposium

38 (Invited) Do the gastrointestinal microflora of non-ruminants contribute to the amino acid needs of their host? M. Fuller*, *Stony Brook University, Stony Brook, NY.*

Non-ruminants have a large and highly active population of gastrointestinal microflora which are intimately involved in the digestion of food and the recycling of nitrogen. Absorption of amino acids synthesized by the microflora has been observed by giving [¹⁵N]ammonia or [¹⁵N]urea and measuring the entry into the body of [¹⁵N]lysine (which does not transaminate) or by giving [¹⁴C]polyglucose and observing the uptake of [¹⁴C]-labeled indispensable amino acids. Germ-free rats showed no [¹⁵N]lysine labeling after [¹⁵N]ammonia was given. Rats in which coprophagy was prevented also showed no lysine labeling: in this species, at least, microbial amino acids are obtained only by coprophagy. In experiments with pigs, however, coprophagy was prevented and in this species, and also in human subjects, microbial lysine was absorbed in nutritionally significant amounts. In pigs, most of this absorption occurred in the upper digestive tract, not in the large intestine. This does not necessarily mean that microbial amino acids make a significant net contribution to meeting the host's amino acid needs: that depends upon whether the microbial amino acids are synthesized de novo from materials such as non-starch polysaccharides and urea, or whether microbes utilize for protein synthesis pre-formed amino acids from the diet, or from the endogenous secretions of the host, that would otherwise have been absorbed directly. Observations in pigs suggested that only a small proportion of valine was synthesized de novo. However, by giving human subjects antibiotics it was estimated that the microflora supplied approximately 20% of the daily leucine requirement. While there is little doubt that microbial amino acids are absorbed, and that a proportion of these is synthesized de novo, important questions remain.

Key Words: amino acid, non-ruminant

39 Does lysine level fed in one phase influence performance during another phase in nursery pigs? J. E. Nemecek*, M. D. Tokach, S. S. Dritz, R. D. Goodband, J. M. DeRouchey, and J. L. Nelson, *Kansas State University, Manhattan.*

A total of 320 weanling pigs (PIC barrows, initially 5.7 kg and 21 d) were used in a 35-d trial to determine whether the lysine level fed during one phase in the nursery influences the response to dietary lysine during another phase. Eight dietary treatments were allotted and arranged as a 2 x 2 x 2 factorial, with 5 pigs/pen and 8 pens/treatment. Diets were fed in 3 phases, with each treatment being assigned as normal or low lysine level. Standardized ileal digestible lysine levels were 1.35 vs 1.55% during phase 1 (d 0 to 7), 1.15 vs 1.35% in phase 2 (d 7 to 21), and 1.05 vs 1.25% during phase 3 (d 21 to 35; see table below). Pigs and feeders were weighed on d 0, 7, 14, 21, 28, and 35 following weaning to calculate ADG, ADFI, and G:F. There were no dietary interactions between phases ($P > 0.12$). From d 0 to 7 increasing the dietary lysine did not influence ($P > 0.37$) ADG (160 vs 157 g) or ADFI (151 vs 164 g), but improved ($P < 0.006$) G:F (1.05 vs 0.96). Similar to phase 1, increasing dietary lysine from d 7 to 21 did not influence ($P > 0.18$) ADG (370 vs 352 g) or ADFI (512 vs 521 g), but improved ($P < 0.03$) G:F (0.72 vs 0.68). From d 21 to 35, the high lysine diet improved ($P < 0.001$) ADG (599 vs 559 g) and G:F (0.65 vs 0.61). We did not detect an influence of the lysine level fed during an earlier phase on the response

to lysine during a subsequent phase. However, the lysine level fed during the late nursery phase had a greater impact on overall performance than the level fed in earlier phases.

Table 1.

D 0 to 7, %	1.35	1.35	1.35	1.35	1.55	1.55	1.55	1.55	
D 7 to 21, %	1.15	1.15	1.35	1.35	1.15	1.15	1.35	1.35	
D 21 to 35, %	1.05	1.25	1.05	1.25	1.05	1.25	1.05	1.25	SEM
D 0 to 7									
ADG, g	161	151	152	162	155	163	159	161	20
G:F	0.96	0.93	0.97	1.00	1.05	1.09	1.07	0.98	0.06
D 7 to 21									
ADG, g	363	365	366	371	346	333	370	375	16
G:F	0.67	0.69	0.72	0.71	0.68	0.66	0.74	0.72	0.02
D 21 to 35									
ADG, g	561	616	579	614	555	573	540	593	27
G:F	0.60	0.67	0.61	0.64	0.61	0.65	0.61	0.64	0.01
D 0 to 35									
ADG, g	402	422	407	426	389	395	395	419	11
G:F	0.65	0.69	0.67	0.68	0.66	0.68	0.68	0.69	0.01

Key Words: lysine, nursery pig

40 (Invited) Amino acid nutrition for efficient immune responses. B. D. Humphrey*, *California Polytechnic State University, San Luis Obispo.*

The immune system manages the amount and location of pathogens within the body. While it is important for the animal to resist disease, the decline in animal performance is the trade-off associated with immune system activation. The ability to minimize this trade-off, that is to have animals resist disease while maintaining high levels of performance, is one way of improving the efficiencies and welfare of animal production systems. Protein and amino acid nutrition is tightly interwoven into immunophysiology, both in healthy and diseased animals. Activation of the innate immune system results in a metabolic response that results in altered nutrient use, especially for amino acids. Nutritional approaches aimed to complement the amino acid needs of an activated immune system may help to prevent excessive endogenous losses and help to promote efficient immune responses. Understanding these relationships will provide a better understanding of how protein and amino acid nutrition can be utilized to provide nutritional support to the immune system with the long-term goal of promoting animal health and performance.

Key Words: amino acid, immune system

41 (Invited ASAS Animal Science Young Scholar) Methionine sources in swine nutrition: Current knowledge and future directions. J. A. Jendza* and O. Adeola, *Purdue University, Department of Animal Sciences, West Lafayette, IN.*

There has been extensive research attempting to determine the bio-efficacy of the hydroxy analog of Met (MHA) relative to synthetic DL-Met in poultry. However, much less work has been done to achieve the same goal in swine. Efforts along this line have been impeded by

high inherent variability masking potential differences. Our efforts yielded bioefficacy estimates of 79.7% with a 95% confidence interval (CI) of 41.4 to 118.1% for percent N retention, and 75.6% with a 95% CI of 49.7 to 101.5% for biological value in 14-kg barrows. An earlier systematic review resulted in estimates of 82% with a 95% CI of 55 to 110% for body weight gain or N-retention, and 81% with a 95% CI of -213 to 374% for feed conversion. The widths of these CI make detection of potential differences extremely difficult, if not impossible in some cases. Based on in vitro studies, it had been suggested that post-absorptive utilization of MHA is not different from that of DL-Met, and that any perceived differences in bioefficacy are the result of superior DL-Met digestibility. However, data from our lab indicate complete disappearance of MHA from the lumen of the gut by the end of the duodenum in 25-kg barrows, which is in agreement with an earlier report involving 36-d-old broilers. Presumably, MHA is absorbed primarily in the stomach where the low pH and presence of the monocarboxylate transporter greatly favor MHA uptake. A recent re-evaluation of bioefficacy estimates in the broiler literature indicate that MHA has greater potential for promoting growth than DL-Met, hinting that MHA may not behave as a titration of DL-Met. This last is a fundamental requirement in the regression techniques routinely used, and may shed light on why attempts to determine the bioefficacy of MHA relative to DL-Met have yielded estimates with such unsatisfactory precision. If MHA does not perform as a titration of DL-Met in swine, then it is unlikely that a single bioavailability coefficient can be determined for predicting the DL-Met replacement value of MHA.

Key Words: bioefficacy, methionine, methionine hydroxy analog

42 (Invited) Developing low protein, amino acid supplemented diets for swine. L. L. Southern^{*1}, M. L. Roux¹, A. M. Waguespack¹, S. Powell¹, T. D. Bidner¹, and R. L. Payne¹, ¹Louisiana State University Agricultural Center, Baton Rouge, ²Evonik-Degussa Corp., Kennesaw, GA.

Supplemental AA (Lys, Thr, Met, Trp) in swine diets have been investigated for at least 50 yr and have been used in practice since the 1970s. These AA are included into swine diets for economical, production efficiency, and environmental reasons. The level to which they are supplemented into diets varies depending on ingredient cost; and at times, one goal might be to maximize the use of these supplemental AA. Conceptually, one should be able to supplement these 4 AA into swine diets until the next AA becomes limiting; i.e., the fifth limiting AA. Research into the maximum inclusion levels of supplemental AA must follow certain fundamental concepts. First, the Lys requirement of the pigs must be known, and this requirement will be influenced by the statistical model used to estimate the requirement. Second, one must then incrementally supplement Lys along with Thr, Met, and Trp into the diet with the standardized ileal digestible (sid) dietary Lys level set at the requirement. Third, the ratios of Thr, Met, and Trp to Lys must be constant at all incremental levels of Lys supplementation and they must be at predetermined levels that maximize growth performance. As one incrementally increases addition of these AA, growth performance will be decreased at some level of inclusion, which is when the fifth limiting AA or total N is no longer adequate to allow maximum growth performance. Our research indicates that the sid Lys requirement for 20 to 40 kg pigs is 0.83%, and that a diet with 0.334% supplemental Lys results in decreased growth performance. Pigs fed a diet with 0.264% supplemental Lys had growth performance that was not different from pigs fed the positive control diet. Addition of supplemental Val + Ile, Val + Ile + His, or Val + Ile and changing the Met:Cys in the diet with

0.334% Lys did not maximize maximum growth performance. However, supplementation with Val + Ile in addition to Gly and Glu resulted in maximum growth performance. The Glu served as a N source, but the Gly could not be replaced with N. In summary, Val is the fifth limiting AA in low CP diets supplemented with Lys, Thr, Trp, and Met, but Ile, Gly, and N are necessary to maximize growth performance.

Key Words: swine, amino acids

43 Determining the optimum ratio of standardized ileal digestible (SID) isoleucine to lysine for growing pigs fed wheat-barley based diets. M. D. Lindemann^{*1}, A. D. Quant¹, J. H. Cho¹, B. J. Kerr², G. L. Cromwell¹, and J. K. Htoo³, ¹University of Kentucky, Lexington, ²United States Department of Agriculture, Ames, IA, ³Evonik Degussa GmbH, Hanau, Germany.

An effective means to reduce nitrogen excretion is by reducing the level of dietary crude protein and adding supplemental amino acids (AA). Isoleucine is generally considered to be the third or fourth limiting amino acid in wheat-barley based diets fed to pigs. Although the Ile requirements of pigs have been researched quite extensively, relatively few have examined the Ile to Lys (Ile:Lys) ratio requirement. An experiment was conducted to establish the optimum dietary standardized ileal digestible (SID) Ile:Lys ratio required to maximize growth rate and to minimize plasma urea nitrogen (PUN) levels in growing pigs fed wheat (60%) and barley (28%) based diets. In a 21-d experiment, 80 pigs with an initial BW of 24.0 ± 3.0 kg were blocked by gender and BW and allotted to 5 dietary treatments with 4 pigs/pen. The basal diet was formulated to an SID Lys of 0.91% (1.00% total Lys) with the addition of L-Ile to the basal diet to create 5 Ile:Lys ratios (SID/total basis: 38.7/39.8%, 46.0/46.5%, 53.3/53.2%, 60.7/59.8%, and 68.0/66.5%). During the 21-d experiment, ADG (528, 647, 712, 656, and 671 g, respectively) increased linearly ($P = 0.020$) and quadratically ($P = 0.027$) as SID Ile:Lys ratios increased. Linear and quadratic broken-line analyses revealed optimum SID Ile:Lys ratios of 48.0% ($P = 0.024$) and 52.4% ($P = 0.010$), respectively. The PUN response (12.6, 11.4, 11.5, 10.5, and 11.5 mg/dL, respectively) displayed a linear ($P = 0.038$) and quadratic ($P = 0.067$) decrease as SID Ile:Lys ratios increased. Linear and quadratic broken-line analyses revealed optimum SID Ile:Lys ratios of 60.8% ($P = 0.108$) and 60.7% ($P = 0.168$). The average of the ADG and PUN optima from linear and quadratic broken-line analyses revealed optimum SID Ile:Lys ratios of 54.4% (54.2% on a total AA basis) and 56.5% (56.1% on a total AA basis) respectively for 24 to 35 kg pigs that were fed a barley and wheat based diet. This estimate is slightly lower than the ratio of 60% reported from previous ideal AA pattern studies in swine, but agrees well with the calculated ratio of 54% from the NRC (1998).

Key Words: isoleucine, lysine, pigs

44 (Invited) Practical amino acid formulation for sows and pigs. J. Hedges^{*}, Ralco Nutrition, Inc., Marshall, MN.

Practical commercial swine diets have been formulated since the 1970s using synthetic lysine and methionine. When threonine became economical this allowed the use of additional supplemental lysine. Recently synthetic tryptophan priced into commercial diets for GF hogs resulting in diet cost saving. With tryptophan economical this merits serious consideration of the branched chain amino acid requirement. This talk will focus on digestible amino acid levels of ingredients and how the amino acid levels of ingredients have changed over the years,

how this impacts the use of synthetic amino acids, and the amino acid ratios from a practical use standpoint. Data will also be presented to show the advantage of synthetic amino acids in terms of diet cost, swine performance and environmental impact. There are trials that show the use of synthetic amino acids improves swine performance or at least provides comparable results to protein formulated diets. DDGS adds another facet to the use of synthetic amino acids, data showing the value of synthetics with DDGS will be reviewed. The use of synthetic amino acids in sow diets will also be reviewed. The genetic improvements that have occurred in sow body composition and prolificacy have resulted in approximately a 50% increase in lysine requirement over the gestating sows used for the 1998 NRC (8.7 g TID lysine/day then vs. 13 g/day

now). The gilt lactation lysine intake generally accepted today is significantly greater than the 1998 NRC. It has been the general consensus that synthetic lysine could not be used for sows or at a very minimal level. Work conducted by Ralco nutrition will be reviewed which compared 0.1%, 0.2% and 0.3% added L-lysine to gilt lactation diets. The diets were corn soybean meal based diets with fat added at 60 pounds per ton. The threonine, methionine and cystine ratios were kept constant but the ratio of tryptophan and valine were reduced as the level of L-lysine increased. Normal reproductive parameters were monitored and there were no significant differences observed between dietary treatments.

Key Words: amino acids, sow amino acid, L-lysine use

Equine

45 (Invited) Obesity-associated insulin resistance and its relationship to laminitis. R. Carter*, *Department of Clinical Studies/New Bolton Center, University of Pennsylvania School of Veterinary Medicine, Kennett Square.*

Obesity has become a major health concern in equids due to its increasing prevalence and association with insulin resistance and risk for disease, especially laminitis. Additionally, regional obesity, particularly along the crest of the neck, is implicated with a greater risk for insulin resistance and disease than generalized obesity alone. Identification of equids with increased risk for laminitis involves the proper assessment of obesity and insulin resistance, and the application of criteria for specified risk factors. As research solidifies the causative associations of obesity with insulin resistance, and of insulin resistance with laminitis, the physiological and molecular mechanisms behind these associations are still essentially unidentified. Possible mechanisms of obesity-induced insulin resistance are deduced from equine data or inferred from studies in other species, and include the influence of inflammatory cytokines, adipokines, free fatty acids, or intramyocellular triglycerides. While the molecular mechanisms linking obesity and insulin resistance with laminitis are currently unknown, several theories, including vascular or enzymatic effects of insulin signaling pathways, have arisen as interesting avenues for future research progression.

Key Words: laminitis, obesity, insulin resistance

46 Lactic acid bacteria isolated from the equine stomach. A. H. Smith* and T. G. Rehberger, *Danisco, Waukesha, WI.*

Although it is well-accepted that the non-glandular region of the equine stomach is colonized by actively fermenting lactic acid bacteria, there is very little data available in the literature on the diversity of bacteria inhabiting the equine stomach and frequently the data available is from a limited number of animals. This study was performed to isolate culturable lactic acid bacteria from the stomach of horses in order to determine if there is a core equine stomach lactic acid bacterial microbiota. Lactic acid bacteria were isolated from non-glandular stomach sections obtained from ten horse carcasses at a slaughter facility. Random amplified polymorphic DNA (RAPD) analysis was used to compare the genomic diversity of isolates. Isolates representing the RAPD diversity from each horse were selected for sequencing of the 16S ribosomal gene. The 16S ribosomal gene sequence was used to identify the bacteria with EzTaxon, a web-based tool to classify bacterial species. The Simpson's

Index of Diversity (1-D) for each horse based on the abundance of each species identified ranged from 0.43 (2 species isolated) to 0.83 (8 species isolated). *Lactobacillus* was the most predominant genus with eight species identified and were isolated from all, but one horse. Streptococci were isolated from eight horses and all isolates were related to the *Streptococcus equinus/lutetienis/infantarius/galloyticus* group. The other genera represented were *Enterococcus*, *Pediococcus*, *Weissella* and *Lactococcus*. Two species, *L. plantarum* and *P. pentosaceus*, have not been identified in previous studies on equine bacteria. Novel lactic acid bacteria were not obtained in this study, but no attempts were made to isolate bacteria that do not grow readily on MRS agar. The differences in the composition of culturable bacterial species between horses were large and therefore, no core lactic acid bacterial microbiome could be identified for these ten horses.

Key Words: lactobacillus, streptococcus, stomach microbiota

47 Relevant equine intensive nutrition software. P. Auwerda* and G. Dahke, *Iowa State University, Ames.*

Relevant Equine Intensive Nutrition Software (REINS) is a total mixed ration (TMR) program that allows for evaluation and formulation of protein, energy, vitamin and mineral requirements of horse rations across multiple stages of production. The program considers body condition score, production stage, desired growth, work intensity, weather conditions and feedstuff utilization as criteria to determine if nutritional demands of the horse are met. Requirements are based off of the 2007 NRC Nutrient Requirements of Horses. The software is written in MS Visual Basic and uses MS Excel as the user's interface to operate. A least cost formulator can be used or rations can be entered manually. An extensive feed library is included that can be modified to add feedstuffs or change the nutrient composition of a feedstuff. Every nutrient, including starch, amino acids, vitamins minerals and a number of fatty acids are listed for feedstuffs. There is room for 220 feeds in the feed library. Multiple feed libraries can be created which allows a user to assign a feed library to a farm. Appendixes are comprehensive including unit converters, digestible energy calculations, converters for suggested growth rate, body condition score, environment and exercise. Printouts include a ration performance summary, an adequacy graph, ration ingredient analysis summary, supplement summary, price analysis and a batch sheet that can be in terms of animal numbers or batch weight.

Key Words: horse, nutrition, software

48 (Invited) An update on horse welfare, contrasting the issues between developed countries and developing countries. C.R. Heleski*, *Michigan State University, East Lansing.*

Worldwide there are approximately 55 million horses; approximately 80 percent perform working tasks in developing parts of the world. Over 75 percent of horse-related resources, though, go toward the minority of horses who live in the developed world and perform tasks related to competition and/or recreation. The welfare issues affecting these dichotomous populations vary dramatically. In developing parts of the world, providing sufficient amounts of food to maintain something close to a moderate body condition score is challenging; providing enough clean, safe drinking water to avoid dehydration can not be taken for granted; parasite management programs are almost unheard of; salt provision is rare; and health care, especially in the case of injuries, can appear barbaric and often provides no benefit whatsoever. In contrast, horses in the developed world appear at first to have an idyllic situation. In most cases, they have sufficient nutritional resources to maintain moderate body condition score; in fact, one welfare problem in the developed world is obesity and associated problems. Water is almost never an issue, nor is salt provision, or, in most cases, parasite management. Equine veterinary care has reached an unprecedented level and exceeds the health care of humans in much of the world. But what if we try to look at horse welfare through the eyes of the horse? How many horses in the developed world lack sufficient social interaction? Or lack the opportunity for turnout at liberty? Or lack the opportunity to forage the majority of the day as they would in the wild? Fortunately for human owners, the horse is a highly adaptable domesticated animal, but the horse industry in the developed world still needs to ask itself if they are treating their horses fairly. Some of the practices that are done in the name of aesthetic modifications are truly questionable in terms of ethical appropriateness. Some of the training practices that are imposed are also unlikely to pass ethical scrutiny. The welfare of a horse should not be judged solely on meeting its physiological needs but also striving to meet behavioral needs.

Key Words: horse, welfare, equine

49 The gelding project. K. Martinson*¹, J. Wilson¹, T. Turner², B. Colombo³, C. McKenzie⁴, and D. Fitzpatrick⁵, ¹*University of Minnesota, St. Paul,* ²*Minnesota Horse Council, St. Paul,* ³*Minnesota Animal Humane Society, Golden Valley,* ⁴*Sundown Horse Shelter, Hugo, MN,* ⁵*Minnesota Hooved Animal Rescue, Zimmerman.*

The Minnesota Horse Welfare Coalition (MHWC) was developed in 2008 in response to the growing number of equine related humane cases in Minnesota (MN). MHWC includes the MN Horse Council, MN Animal Humane Society, equine rescues, University of MN, and MN Association of Equine Practitioners. The Coalitions Gelding Project is made up of two programs that encourage horse owners to geld their stallions; Education Earns Stallions to Geldings and Castration Clinics. Education Earns Stallions to Geldings encourages horse owners to geld stallions through education and financial incentives. Horse owners who enroll in the program can earn a voucher for a castration once they attend eight horse health and management education sessions. Session topics include general horse care, reproduction, nutrition, facilities/manure management, equine dentistry, vaccinations and de-worming, horse behavior, and unwanted horse or volunteering two hours at a MN horse rescue. Stallions must be halter broke and have two descended testicles. The voucher covers the cost of castration, anesthesia, post operative antibiotic and tetanus prophylaxis. The MN Horse Council reimburses participating veterinarian for the service. Participants must be 18 years old and a MN resident. The second aspect of the program is a series of free equine castration clinics, the first of which was held in September of 2009. To be eligible, horse owners must be referred by a horse rescue, humane agent or veterinarian based on an economic hardship. Castrations are performed by veterinary students under supervision by licensed veterinarians. At the first castration clinic, 18 stallions were castrated; including three Pintos, three Quarter horses, four miniature horses, two miniature donkeys, four Arabians, one Shetland pony, and one Peruvian Paso. The stallions ranged in age from four months to 19 years old. The horse owner demographics were 82% female, 75% 40 years old or older, 82% owned six or more horses and 27% operated boarding stables. Forty-five percent of participants stated they would not have castrated their stallions without the clinic, and 63% still had stallions on their property which had resulted in both intentional and accidental breedings.

Key Words: unwanted horse, castration

Extension - Beef/Small Ruminant

50 (Invited) Matching the cow to forage resources. D. L. Lalman*, C. P. McMurphy, G. L. Mourer, A. J. Sexten, G. E. Selk, and D. R. Stein, *Oklahoma State University, Stillwater.*

Land, fertilizer, feed, fuel and labor costs continue to increase relative to the value of carcass beef and weaned calves. Consequently, profit motivated commercial cow/calf operations must become more cost-efficient to maintain or improve profit margins. One logical solution is to select and breed cattle that are productive in a given environment while requiring minimal labor and supplemental feed inputs. Planned crossbreeding systems have been shown to increase lifetime kg of calf weight weaned by 25% compared to purebred cows. Nevertheless, breed association registration records suggest that the use of planned crossbreeding systems in the U.S. has declined in recent years. Industry trends suggest that standard genetic prediction tools (such as EPDs and selection indexes) have been embraced by the industry and substantial change has been affected in the past 15 to 20 years. For example, the genetic trend for weaning and yearling growth, marbling and rib eye area EPDs have increased dramatically in each of the 5 breeds of cattle with the greatest number of registrations in the U.S. Concurrently, the genetic trend for birth weight and mature cow size appears to have stabilized. While many of the genetic changes likely represent positive trends in commercial cow/calf enterprise profitability, some trends require closer scrutiny by academic and industry leaders. For example, in several popular breeds the genetic trend for increased milk yield continues at an alarming rate. This trend is remarkable considering the increased requirements for maintenance energy, production energy, CP, and forage DMI associated with increased milk yield. Within breed adjustment factors for maintenance energy requirements associated with increased milk yield are needed. Recent research suggests that in some environments, forage quality limits expression of full genetic potential for milk yield. This scenario should lead to no improvement in calf weaning weight while cow maintenance costs continue to increase. We submit that continued selection for increased muscling and increased growth should also be further scrutinized for their potential impact on beef cow efficiency.

Key Words: genetics, efficiency, beef cows

51 (Invited) Potential to create carbon credits from beef production practices. D. B. Faulkner*, *University of Illinois, Urbana.*

Climate change has become an important issue under current political conditions. This may result in the passage of a “cap and trade” bill which creates a market for carbon credits. Carbon dioxide is used as the reference greenhouse gas and all other gasses are compared using carbon dioxide equivalents. The primary gas of concern for beef producers is methane. It has a heat trapping potential 21 times greater than carbon dioxide. Carbon sequestration involves processes that remove carbon dioxide equivalents from the atmosphere. There are three ways to reduce methane emissions by beef cattle: 1) manipulate the diet, 2) use genetic selection to improve efficiency and 3) reduce the life cycle of the animals. Diet factors that influence methane emissions are level of feed intake, type of carbohydrate in the diet, feed processing, additions of lipids to the diet, and alterations of rumen microflora through compounds like ionophores. High forage diets produce more methane than high grain diets. This is the basis of ratio based equations of meth-

ane production. Intake level can be deliberately restricted to reduce methane emissions. Programmed feeding of high grain diets to stocker cattle and cows combines reduced intake and diet type to dramatically reduce methane emission. Addition of lipids to diets competes for H used for methanogenesis thus reducing methane production. Compound like ionophores alter rumen microflora and reduce methane emissions. Genetic selection for efficiency through residual feed intake will reduce feed intake while maintaining performance. The largest potential reduction in methane production is through reducing the life cycle of the calf. Simply feeding the calf higher energy diets will reduce methane production with concentrate feeding. It will also increase rate of gain which results in a reduction in days to slaughter which dramatically reduces methane emissions. There is potential to create carbon credits through beef production practices. There are challenges in documenting the changes in beef production practices, aggregating the credits and marketing the credits, but the potential returns to the beef industry are huge.

Key Words: carbon credits, beef

52 (Invited) Managing phosphorus supplementation to enhance the economic and environmental sustainability of beef cow-calf operations. J. R. Russell*¹, M. M. Haan², and K. A. Schwarte¹, ¹*Iowa State University, Ames,* ²*Michigan State University-Kellogg Biological Station, Hickory Corners.*

Phosphorus (P) is a mineral that is required for the development and maintenance of bones and teeth, cellular growth and structure, energy metabolism, maintenance of acid-base balance, and growth and metabolism of rumen microorganisms in beef cows. Because supplemental P prices have increased more than 4-fold in recent years, overfeeding of P increases the amounts and solubility of P excreted, and improper grazing management may result in P loading and eutrophication of surface water sources, strategic P supplementation considering the P concentration of pasture forages, grazing selection, and the metabolism and requirements of P in grazing cattle is needed. Phosphorus concentrations in forages are dependent on the forage species and maturity and the pH and concentrations of available-phosphorus and nitrogen in the soil. Hand-clipped samples of smooth bromegrass forage grown on soils having optimum levels of Bray-1 P have been found to contain from 0.22 to 0.34% P in the spring and 0.16 to 0.24% P in mid-summer; values above the P requirements of a lactating beef cow. Smooth bromegrass grown on soil that had previously received high application rates of feedlot manure contained 0.41 to 0.53% P. Because P concentrates in green plant tissues, management practices that enhance vegetative tissue will increase the P concentration of the total forage. Furthermore, the P concentration of forage selected during grazing may be 54 to 128% greater than hand-clipped forage after adjustment for salivary P. Selective grazing may also minimize the need for P supplementation of cows grazing corn crop residues as long as some grain is available for selection. Forage P concentration will dramatically decrease after a killing frost. Therefore, P supplementation should be considered when pasture soils are deficient in P, pasture forages have either been allowed to mature or killed by a frost, or corn crop residues are grazed that are devoid of downed grain.

Key Words: phosphorus, beef cows, grazing

53 (Invited) On-farm mortality composting of large animal carcasses. J. Payne*¹ and B. Pugh², ¹Oklahoma State University, Oklahoma Cooperative Extension Service, Muskogee, ²Oklahoma State University, Oklahoma Cooperative Extension Service, Stigler.

Large animal carcass disposal remains a problem throughout the US. For many livestock producers, carcass disposal options are limited and can be costly. Improper carcass disposal can degrade surface and groundwater and result in increased disease transmission, endangering the health of humans, domestic livestock, wildlife and pets. Composting dead animal mortalities is an inexpensive, biosecure and environmentally sound approach to addressing the issue of carcass disposal. An on-farm large animal composting study was conducted to determine the efficacy of 3 bulking agents for composting stocker calf carcasses. The treatments consisted of pine shavings (S), a 50:50 mixture of pine shavings and poultry litter (S&L), and hay (H). Each treatment was replicated 4 times. Twelve separate compost bins were constructed and carcasses were placed on the center of a 2.4 × 2.4 × 0.6 m pad of bulking agent. Carcasses were completely surrounded with at least 0.46 m of additional bulking agent. The piles were left undisturbed while temperature was monitored using long-stem thermometers and data loggers. On days 75 and 150, each pile was turned. Samples were collected on day 150 for analysis of pH, C, S, P, K, Ca, Mg, Na, Cu, Zn, Mn, Fe, NH₄-N, NO₃-N and soluble P. Significant C reductions were observed in S&L and H while significant increases in N were observed in all treatments. Temperature range and mean for S, S&L, and H were (17.05 to 65.18; 50.33°C), (24.63 to 70; 54.55°C), and (4.82 to 55.93; 32.75°C), respectively. S and S&L formed a humus-like product, maintained sufficiently high temperatures required for effective pathogen kill (≥55°C), and were more effective at decomposing bones when compared to H.

Key Words: livestock composting, carcass disposal, livestock mortality

54 (Invited) Filling in the gaps in forage and feed needs. G. P. Lardy*, North Dakota State University, Fargo.

Cow calf producers face significant economic challenges from rising input costs driven by increases in energy prices. These challenges will necessitate structural changes and alternative approaches to management in order to improve profitability and make operations economically sustainable over the long term. To fill gaps between forage and feed needs, cow calf producers should take a systematic approach to determining feed demands. Conceptually, this is a relatively straightforward process consisting of five steps: 1) inventory feeds on hand and determine nutrient composition, 2) inventory current herd numbers by animal type (e.g., age group, production status), 3) estimate feed resources required for each group (based on DM intake and days of available grazing or feeding), 4) target feed resources for specific categories of cattle based on nutrient requirements, 5) identify deficiencies in forage supplies and specific nutrients, and 6) identify the most economical alternative for filling the deficiencies. The use of a computer spreadsheet can be employed as a means of developing the feeding plan. A spreadsheet approach will also allow producers to evaluate various scenarios regarding supplemental feeding. Once nutrient requirements are known and nutrient supplies calculated, producers can calculate supplemental nutrient needs. Gaps in nutrition may be filled using a variety of sources, and producers should explore traditional (e.g., cereal grains, harvested forages) as well as alternative feed sources (e.g., coproducts, annual

forages, cover crops) as a means to provide adequate nutrition for their cow herd. Careful cost analysis of viable alternatives will allow producers to make informed decisions regarding supplementation and improve economic sustainability of cow calf operations.

Key Words: beef cow, forages, nutrition

55 Extended storage of modified distillers grains. D. D. Loy*, D. R. Strohbehn, H. J. Sellers, and D. G. Morrical, Iowa State University, Ames.

Modified distillers grains (MDG) are becoming more common feedstuff in the Midwest. MDG are partially dried distillers grains with additional condensed distillers solubles added at the plant to produce a product that is typically 50% dry matter (DM). Extended storage of high moisture distillers grains offers beef producers the ability to take advantage of seasonal oversupplies. Often small to medium sized producers must purchase MDG in (quantities that must be stored long term to avoid spoilage. Two demonstration trials were conducted to evaluate storage losses and animal performance of MDG stored by different methods. Storage losses were calculated from purchase to feeding. In trial 1, 72.5 tons of MDG were delivered to the McNay research farm in Southern Iowa and packed into a 2.4 m plastic silo bag. The product was fed from days 35 to 207 d after storage in diets formulated to provide 0, 17, or 32% of the DM to Angus heifers. The heifers (145 hd) were fed in six pens (2 pens per treatment). Daily gain increased ($P < 0.01$) and DM intake decreased ($P < 0.05$) with increasing MDG for the first 46 d on feed. Daily gain increased with increasing MDG for the subsequent periods (43 and 33 d, $P < 0.01$). Overall daily gain did not differ among treatments, but DM intake did decrease as MDG level increased ($P < 0.05$). There were no significant differences in reproductive status of the heifers. Significant spoiled and moldy feed was noted and discarded in the first feeding period and decreased as the feeding rate increased. The storage losses from all sources including discarded feed totaled 16.7%. In trial 2, three loads of MDG ranging from 24 to 26 tons were each stored in individual covered pyramid piles. Piles were covered in 4 mm plastic and sealed with ground limestone. The product was fed as a supplement to wintering cows. The first pile was opened 85 days after storage, and the last pile was opened after 211 days. Storage losses were 9.49%, 11.27% and 7.2% for the three loads.

Key Words: modified distillers grains, storage losses

56 Extended storage of wet distillers grains mixed with ground hay. D. D. Loy*, D. R. Strohbehn, H. J. Sellers, and D. G. Morrical, Iowa State University, Ames.

Extended storage of high moisture distillers grains offers beef producers the ability to take advantage of seasonal oversupplies. Often small to medium sized producers must purchase wet distillers grains (WDG) in quantities that must be stored long term to avoid spoilage. Three demonstration trials were conducted to evaluate storage losses and animal performance of a mixture of 80% WDG and 20% hay (as-fed) by different methods. In trial 1, 57.5 tons of the WDG-hay mixture were mixed by mixer wagon and stored in a silo bag for 40 to 90 days, with a storage loss of 9%. Storage losses were calculated from purchase to feeding. In trial 2, 45 tons of the mixture were mixed by mixer wagon, packed in a bunker silo and covered with plastic. The mixture was fed

to growing calves for 118 days. Performance was compared to calves fed the same ingredients mixed daily or a control (C) diet of corn, hay, soybean meal and supplement. Performance did not differ across treatments, except that C calves had higher feed intake ($P < 0.05$). Storage losses were 10.5% for the mixture. In trial 3, 102 tons of WDG and 27 tons of ground fescue hay were mixed into a temporary silo constructed with plastic lined, large round bales with a loader tractor. The mixture was covered in plastic and ground limestone, and fed to 124 Angus heifers from 99 to 250 days after storage. The heifers were fed a diet containing 42-59% of the mixture or a control diet consisting of

corn, haylage, soybean meal and a mineral supplement. Heifers fed the WDG-hay diet gained slower ($P < 0.05$) than the control heifers, but there were no statistical differences in pregnancy rate. Storage losses were 9.83% in this study. Feed samples were collected over the course of feeding in trial 2 (n=6) and trial 3 (n=7) to evaluate the effectiveness of mixing with the loader tractor. The coefficient of variation of these samples was 7.1, 10.2, and 3.6 for % DM, % protein and % NDF in trial 3; and 4.4, 3.3, and 6.5 for the same analyses in trial 2.

Key Words: wet distillers grains, storage losses

Extension - Dairy

57 Effect of bedding material on performance, health, and hide contamination of calves reared in hutches. K. D. Gay*¹, S. D. Eicher², C. S. Wilcox^{1,2}, J. A. Bridges¹, M. H. Rastagno², S. E. Charley¹, and M. M. Schutz¹, ¹Purdue University, West Lafayette, IN, ²USDA-ARS Livestock Behavior Research Unit, West Lafayette, IN.

Dairy calf hutches are often bedded with straw (STR), but sand (SND) and wood shavings (SHV) are becoming more common. This study compared 3 different beddings for growth and health of calves and microbial presence on their hides. Hutches were blocked by location and each of 3 hutches in a block was randomly assigned 1 of 3 treatments; SND, STR, or SHV. Twenty-eight heifer calves in the study were assigned sequentially by birth date to the next available hutch. The study was conducted during a moderate summer (June to September, 2008) at the Purdue Dairy Research and Education Center. Calves were observed twice weekly from birth to weaning at approximately 8.5 wk. Weight (BW), hip height (HH), wither height (WH), and heart girth (HG) were measured weekly. Calves were scored for respiratory (RH) and fecal health (FH), and appearance (APP) twice weekly. At 4 and 8 wk of age, hide bacteria swabs were obtained from a 100 sq. cm area on the right mid-abdomen and used to determine total aerobic and coliform populations. Statistical models considered, block and treatment. Additionally, for measures after d 1 of age, covariates of age and birth BW were included. Block affected only WH rate of growth to 4 wk of age and to weaning ($P < 0.05$). Treatment affected weaning HH ($P < 0.05$). Least squares means (LSMEANS) of HH for SND (92.5 cm) and STR (93.8 cm) were greater than for SHV (90.5). However, over the entire period of time, wk ($P < 0.001$) affected all measures of growth, but treatment and its interaction with wk did not. Treatment differences were not detected for RH, FH, APP or total aerobic and coliform counts ($P > 0.05$) at 4 or 8 wk. It appears there are no clear advantages or disadvantages for SND, STR, or SHV as bedding materials with respect to calf growth, general health and hide contamination during moderate summer conditions in the Midwest.

Key Words: bedding, calf, growth

58 An economic decision-making model for comparing reproductive management programs in dairy herds. J. O. Giordano*, P. M. Fricke, M. C. Wiltbank, and V. E. Cabrera, University of Wisconsin, Madison.

A Markov-chain simulation model was developed to compare the net present value (NPV, \$/cow/d) generated by different reproductive programs (RP) in a dairy herd. The daily NPV of a specific RP was calculated by adding the discounted expected monetary values (DEMVs) of

that proportion of cows that become pregnant at each successive services until a maximum predefined DIM plus the DEMV of that proportion of cows not becoming pregnant to the RP. The DEMV for a lactation defined by DIM at pregnancy was calculated based on the value of milk produced, feed cost, expected value of a new born calf, and cost of culling. Economic, productive, and reproductive values were user-defined for each RP evaluated. The model sequentially estimated the percentage of cows eligible for breeding, becoming pregnant, and not becoming pregnant at each service based on the service rate (SR) and conception rate (CR) of each RP. Total service cost including pregnancy diagnosis (PD) was applied to all cows until pregnancy or culling for reproductive failure. For synchronized services, total cost was calculated by adding the individual cost of: treatments, labor, AI, and PD. Total cost for estrous services was calculated by adding the individual cost of heat detection, AI, and PD. A decision tree then compares the NPV for different RPs. A comparison among commonly used programs with typical reproductive values (Table 1) indicated that a Presynch-Ovsynch protocol with 100% TAI (A) for 1st service generated the highest NPV. The greatest difference between RPs (A vs. C) resulted in a NPV advantage of \$29 cow/year (\$0.08/d \times 365 d). To reach maximum NPV RPs (B) and (C) would require an increase in CR to estrous services of 7% and 13% respectively. Utilization of this model by commercial dairy herds may facilitate selection of economically-optimal RP based on farm-specific parameters.

Table 1. Net present value difference among three commonly used reproductive programs.

Reproductive Program	ES before 1st service TAI	CR (%)	1st Service TAI	CR (%)	NPV difference from maximum	CR ² to Maximum
(A) 100% TAI Presynch-Ovsynch & day 32 Resynch	0	0	37	37	Maximum	-
(B) ES ¹ + TAI Presynch-Ovsynch & day 32 Resynch	40	33	33	33	-0.03	40
(C) ES + TAI Presynch-Ovsynch & day 32 Resynch	60	25	33	33	-0.08	38

¹ES = estrous service.

²CR = CR needed at ES to reach maximum NPV.

Key Words: economics, reproductive program, dairy herd

59 (Invited ADSA Young Dairy Scholar) Jersey × Holstein crossbred cows compared to pure Holstein cows for calving traits, production, fertility, survival, and udder measurements during the first three lactations. B. J. Heins*, L. B. Hansen, A. R. Hazel, A. J. Seykora, D. G. Johnson, and J. G. Linn, *University of Minnesota, St. Paul.*

Jersey x Holstein crossbred (JxH, n = 80) and pure Holstein (n = 77) cows were in two research herds of the University of Minnesota and calved from September 2003 to June 2008. The JxH were mated to Montbeliarde sires, and Holstein cows were mated to Holstein sires. GL was significantly ($P < 0.05$) longer for JxH than HOL in first (280.3 d vs. 277.7 d), second (280.7 d vs. 278.4 d), and third (283.8 d vs. 278.8 d) lactation. JxH tended ($P < 0.10$) to have Montbeliarde-sired calves (n=71) with less BW (37.6 kg vs. 38.9 kg) than pure Holstein calves (n=74) during first lactation. For CD and SB, JxH were not significantly different from HOL during the first three lactations. During first lactation, JxH (518 kg) and pure Holstein (526 kg) cows were not significantly different for fat plus protein production. However, during second (605 kg vs. 630 kg) and third (609 kg vs. 660 kg) lactations, JxH cows were significantly ($P < 0.05$) lower for fat plus protein production than pure Holstein cows. The JxH cows were not significantly different from pure Holstein cows for SCS during first and second lactations; however, JxH cows (3.80) tended ($P < 0.10$) to have higher SCS than pure Holstein cows (3.40) during third lactation. For days open, JxH cows had significantly ($P < 0.05$) fewer days open than pure Holstein cows in first lactation (124 d vs. 148 d), second lactation (121 d vs. 163 d), and third lactation (158 d vs. 200 d). For survival to second calving, JxH cows (80%) were not significantly different from pure Holstein cows (71%). However, more JxH cows (64%) tended ($P < 0.10$) to calve a third time than pure Holstein cows. For udder measurements, JxH cows had significantly ($P < 0.01$) less udder clearance from the ground than pure Holstein cows in first (47.8 cm vs. 54.8 cm), second (42.4 cm vs. 51.4 cm), and third (40.4 cm vs. 48.9 cm) lactations.

Key Words: crossbreeding, heterosis, Jersey

60 Water quality and nutrient composition from livestock operations in the United States. D. P. Casper*, F. Talbot, D. Schauff, D. Jones, D. Kleinschmit, E. Lanka, P. Brown, and G. Gengelbach, *Agri-King, Inc., Fulton, IL.*

Water is an important, but often forgotten, nutrient in livestock nutrition. Little information exists in the literature on water quality and nutrient composition and the effect on livestock production. Agri-King, Inc. collects and analyzes water samples for livestock operations when using our nutrition consulting programs. Samples were collected from numerous livestock operations from February 1995 through October 2009 and were submitted to the Agri-King laboratory for determination of bacterial and nutrient composition using standard analytical assays. The objective of the study was to summarize this database to determine the variation in water quality and nutrient composition. The database contains 11,161 individual measurements of water samples collected from around the world of which 9,891 samples are from 34 states representing the major dairy and livestock producing areas in the United States. Due to adding new laboratory assays over time or the request of just conducting selective assays on specific water samples, has resulted in not all analytical measurements being conducted on every individual water sample. The mean, range, and standard deviation (SD) of various water quality and nutrient measurements are given in Table

1. These data show that water quality and nutrient composition can vary tremendously across livestock operations in the United States and these values could influence animal performance. To ensure that water quality and composition are not changing with time, water samples should be collected at least annually from livestock operations.

Table 1. Quality and nutrient composition of water samples from livestock operations in the U.S.

Measurement	N	Mean	Minimum	Maximum	SD
Bacteria, cfu/mL	9891	22.3 ¹	0.0	400	52 ¹
Nitrate-N ²	9890	5.0	0.0	208	7.8
pH	9612	7.1	3.4	10	0.61
TDS ²	9167	438	5	1200	225
Ca ²	8653	66	1	1329	58
Mg ²	8457	24	1	813	22
K ²	6409	6	1	2651	53
Na ²	9196	45	.1	5659	138
Cl ²	6835	49	.1	4519	137
Cu ²	5578	0.06	0.01	12	0.37
Fe ²	7548	0.83	0.01	87	3
Mn ²	6707	0.18	0.01	39	1.1
Zn ²	6769	0.11	0.01	20	0.48

¹Does not include 1,825 water samples where bacteria were too numerous to count.

²ppm.

Key Words: Water, Quality, Nutrients

61 (Invited) Getting the cow off to the best possible start: Should we focus on far-off dry, pre-fresh transition, or post-fresh transition period? R. Grummer*, *University of Wisconsin, Madison.*

Nutritional management of transition cows continues to be a priority among dairy producers and a major focus for university research. Early lactation is when most dairy cows are culled. It is often difficult to identify the cause of early postpartum health problems. It may be nutritional, environmental (e.g. housing), or an interaction between the two. Most nutrition research has emphasized energy feeding schemes during the dry period. For decades, we preached that feeding during the pre-fresh transition period was the most critical time for the prevention of metabolic problems after calving and that it was important to feed additional grain during that period. However, data shows that cows tolerate a wide variety of diets during that time and forage to concentrate ratio has little impact on postpartum lactation performance. In studies where statistical differences in metabolic parameters have been detected, the biological significance of those differences may be trivial. Recently, there has been considerable interest in feeding schemes during the far-off dry period and it has been suggested that it may be a more crucial feeding period than the pre-fresh transition period. To our knowledge, there are only two recent studies that specifically compared far-off dry period energy feeding schemes; their results were contradictory indicating it may be too early to draw any conclusions. There is a fairly substantial body of evidence to indicate that cows should not be over-conditioned at calving. However, it is difficult to significantly increase condition score of cows during the relatively short dry period when feed intake is low. We speculate that the most critical time for feeding transition cows is immediately postpartum. Unfortunately, there is a paucity of data on feeding cows during the first 3 weeks postpartum. Researchers avoid conducting research on cows immediately postpartum because large cow numbers

are needed to provide reliable information. Consequently, research is lacking to confidently recommend optimal energy/carbohydrate feeding strategies for that period.

62 (Invited) Strategies for nutritional management during the dry period: Controlled energy diets. J. K. Drackley*, *University of Illinois, Urbana.*

Feeding dairy cows during the dry period and transition to lactation remains a critical yet controversial subject. Our research over the last decade has led to one strategy that may decrease incidence of periparturient health problems while still allowing cows to reach high milk production. We have termed this general approach as “controlled energy”. The concept is simple - control the intake of the cow to consume the nutrients she needs (or a slight excess) but do not allow significant overconsumption of energy. Our studies show that overconsumption of energy during the dry period consistently leads to higher NEFA and BHBA in blood after calving, and greater lipid deposition in liver. Energy intake can be controlled by limit feeding or by “high fill” diets. Limiting intake of higher nutrient diets can be a workable strategy but requires adequate bunk space and careful management. This strategy is difficult to implement in dynamic herd groups such as the close-up group. Instead, we have focused on high-fill diets - the “Goldilocks” diets or “designed to fill” diets that rely on high forage fiber (typically straw) to dilute energy density and control total DMI. A recent comparison of a single-group dry cow program with a two-stage program showed no benefits to the two-group. A major benefit of the controlled-energy high-fiber diets is more stable DMI leading to calving. These diets work best when the lactation diet ingredients are diluted by straw or other bulky materials. Feeding management is critical to make these systems successful. Mechanistically, we have evidence for improving the suppression of lipolysis after calving and minimizing both ketogenesis and triglyceride deposition in liver. Our recent research with DNA microarrays has demonstrated that even modest lipid accumulation in liver is associated with a host of processes that are detrimental to appropriate liver function.

Key Words: transition period, dry period, dairy cows

63 (Invited) Diet cation-anion difference (DCAD) as a means of controlling milk fever; factors important to implementing DCAD management. J. Goff*, *Iowa State University, Ames.*

Evidence suggests elevated dietary potassium (K) in the diet just before calving is a major risk factor for hypocalcemia and milk fever around the time of calving. Elevated K can cause the cow to develop a metabolic alkalosis- which appears to reduce bone and kidney tissue responsiveness to parathyroid hormone. As a result Ca homeostasis is impeded and the cow is unable to restore blood calcium to normal at the initiation of milk production. Reducing the incidence of milk fever relies upon reducing diet K and feeding anions to the cow to reduce the alkalinity of the blood. Early studies utilizing anionic salts were plagued by poor intake of the total diet as a result of the poor palatability of anions. More palatable anion sources have been developed which mitigate some of these problems. Agronomic studies have outlined steps needed to reduce forage K while also elevating forage chloride content- providing another means of controlling diet DCAD. Diet magnesium pre and post-calving must also be elevated to maintain blood Mg above 1.9 mg/dL if the parathyroid hormone receptor is to function properly. The availability of Mg from commercial sources

varies widely, but can be tested simply. While a cation, diet Ca does not appear to be a powerful alkalinizer of the blood of the periparturient cow.

64 (Invited) Low calcium diets and milk fever. J. D. Ferguson*, *University of Pennsylvania, Kennett Square.*

Milk fever is a condition that affects about 6% of cows at calving (NAHMS, 1996). Major factors influencing the risk of milk fever include breed (Jersey>Holstein), age (4th lactation and older greater risk), milk production, and dietary factors. Dietary content of prefresh diets associated with risk of milk fever include (risk direction with increasing dietary content): Ca (increasing), P (increasing), Mg (decreasing), K (increasing), and S (decreasing). Milk fever is associated with an acute decrease in plasma Ca usually at parturition associated with an increase in Ca output in colostrum. When plasma concentrations decline from normal ranges of 9 to 10 mg/dL to less than 5 mg/dL, cows cannot maintain normal muscle and nerve function and become recumbent. The condition is life threatening if untreated. Treatment is typically intravenous calcium borogluconate (23% Ca), which re-establishes plasma Ca and muscle and nerve function. Declines in plasma calcium to 7 to 9 mg/dL are typical at calving; values between 5 to 7 mg/dL are considered marginally hypocalcemic but are not associated with recumbency. Currently there are two main control approaches to controlling the risk of milk fever: altering the dietary-anion concentrations (DCAD) in prefresh diets, or controlling Ca content in prefresh diets. The DCAD content is calculated as the meq/100g based on the formula $(Na + K) - (S + Cl)$. Strategies to reduce milk fever incidence using DCAD include increasing S and Cl relative to Na and K to reduce DCAD values to 0 or lower. Prefresh diets with Ca concentrations below 0.6% will reduce milk fever incidence. However, concentrations below 0.4% are preferred. Forage sources using corn silage, wheat straw, and grass hays are effective in maintaining low Ca concentrations when no supplemental Ca sources are included in the ration. Corn grain, soybean meal, blood meal, salt, trace minerals, and vitamins complement the forages and Ca concentrations (and P) can be maintained below 0.4%. Magnesium concentrations should meet or exceed NRC recommendations.

65 Evaluation of dripping and drying characteristics, teat coverage persistency, and teat health for two prototype and one commercial dry period persistent barrier teat dips. J. Peters* and L. L. Timms, *Iowa State University, Ames.*

Objective of this study was to evaluate 2 prototype fast drying dry cow teat dips [purple (FP) and green (FG)] compared to a commercially available dip [(T- Hexx Dry, Hydromer, Inc. (Blue-B)], with comparisons of dripping amounts and times post dipping, dip drying times, persistency of dip, and teat end and skin health. Forty-three dry cows and pregnant heifers were used for the study. All teats were cleaned and dried prior to dipping. Teat ends and teat skin were scored by one grader at initiation and end of trial using a 1-5 scale (Timms and Goldberg methods). Fifteen cows were dipped in a half udder design with left teats dipped in B dip (control) and right teats with FG. Amount of time dripping occurred and the amount of dip dripped off were quantified on 5 individual teats of 5 individual cows for each dip (2 teats compared within cow). Dip drying time was measured by touching the teat with a cotton swab starting at 1 minute post dipping and then every 30 seconds. Dip was considered dry when no color or dip showed on the cotton swab. 15 cows were dipped with left teats dipped in B dip (control) and right teats with FP, and 13 cows were dipped with left teats dipped in

FP and right teats with FG. Teat dip persistency or coverage of teats (especially teat ends) was conducted every 12 h and scored using a 1-5 scale (5= complete teat adherence and 1 = dip completely off). Results were analyzed using SAS 2 sample t-tests. Drip time was significantly reduced with FG (55%; 15 s) and FP (40%; 20 s) compared to B (33.5 s). Drip amounts were significantly reduced with FG and FP compared to B (50%, 1 vs 2 mL). Drying times were significantly reduced with

FG (1.6 min; 50%) and FP (1.85 min: 40%) compared to B (3.3 min). Dip B showed longer persistency across teats and cows with higher % of teats covered > 72 hrs (47-67%) compared to both FP (34-46%) and FG (20-34%). There were no differences among dips with regards to teat skin and teat end health.

Key Words: dry period, teat dipping, persistent barrier dip

Extension - Swine

66 (National Pork Board Education Award) Pork Information Gateway serves as online clearinghouse for pork production information. M. T. See*¹, K. Beeler², M. Whitney³, G. Thome⁴, M. Swan⁵, M. Morrow¹, Y. Li³, T. Baas⁶, B. Richert⁷, R. Knox⁸, S. Pohl⁹, A. Sutton⁷, S. Moeller¹⁰, J. Sterle¹¹, P. Holden⁸, M. Hardin¹¹, K. Leedom-Larson¹², D. Newman¹³, D. Meisinger², ¹North Carolina State University, Raleigh, ²U.S. Pork Center of Excellence, Ames, IA, ³University of Minnesota, Mankato, ⁴Riverland College, Austin, MN, ⁵Washington State University, Pullman, ⁶Iowa State University, Ames, ⁷Purdue University, West Lafayette, IN, ⁸University of Illinois, Urbana, ⁹South Dakota State University, Brookings, ¹⁰Ohio State University, Columbus, ¹¹Texas A&M University, College Station, ¹²National Pork Board, Des Moines, IA, ¹³North Dakota State University, Fargo.

The Pork Information Gateway (PIG) was launched in 2006 and enables collaboration among universities and provides producers and their advisors an online forum for accessing information. PIG categorizes information into 17 areas of pork production. Each area of PIG is led by a specialist from one of eleven universities or National Pork Board. PIG currently has 4,080 registered users from all fifty states and District of Columbia. Registration is free and users can access information by downloading and printing, or reading online. Users include producers (n=1319), educators and extension personnel (n=651), students (n=959), industry representatives (n=441), veterinarians (n=168), and other (n=512) members of the pork industry. Sixty-four percent of users are engaged in pork production or provide information directly to pork producers while 24% of users are students. The information available includes peer-reviewed Factsheets (n=228), step-by-step production guidelines (How-To's; n=41), frequently asked questions (Answers; n=1608), learning Courses (n=7), and References (n=1362). User views of content were evaluated for the period of May to October 2009. The most popular content type viewed on PIG was Factsheets (18.1 ± 0.4) and Courses (17.2 ± 1.9) which were viewed 45% ($P < 0.02$) more frequently than How-To's (12.2 ± 1.0) and downloaded six times more often ($P < 0.001$) than Answers (3.7 ± 0.2) or References (3.3 ± 0.3). For this period all Factsheets, Courses and How-To's were viewed while 88% of Answers and 46% of References were viewed. The ten most popular documents were all factsheets with "Estrus or Heat Detection" being viewed 83 times. The most popular content items in Answers, How-To's, References and Courses were viewed 47, 39, 38, and 34 times, respectively. Since the inception of PIG the 1,608 Answers have been viewed on average 1,141 times (220 to 3,233). PIG also provides Factsheets, Frequently Asked Questions, and reference materials to eXtension to populate the Pork Information Community of Practice. PIG provides an online collaborative resource that serves as an information clearinghouse for educators and producers across the nation.

Key Words: pigs, extension, internet

67 Development of a swine nutrient recommendations estimator and diet formulator software to support the National Swine Nutrition Guide. M. H. Whitney*¹, M. S. Carlson², S. D. Carter³, G. R. Dahlke⁴, J. M. DeRouchey⁵, D. Meisinger⁶, D. E. Reese⁷, B. T. Richert⁸, J. F. Patience⁴, R. C. Thaler⁹, and E. van Heugten¹⁰, ¹University of Minnesota, Mankato, ²University of Missouri, Columbia, ³Oklahoma State University, Stillwater, ⁴Iowa State University, Ames, ⁵Kansas State University, Manhattan, ⁶U.S. Pork Center of Excellence, Ames, IA, ⁷University of Nebraska, Lincoln, ⁸Purdue University, West Lafayette, IN, ⁹South Dakota State University, Brookings, ¹⁰North Carolina State University, Raleigh.

Swine nutrition and feeding management is a complex process. Feed is the largest single item among the costs of producing pork; on average, it accounts for about 60% of all costs. A cooperative national effort was undertaken by state University swine nutritionists and the U.S. Pork Center of Excellence to develop a National Swine Nutrition Guide (NSNG). The purpose of the NSNG is to enhance the understanding of basic nutrition, feeding principles and related management practices and to serve as a practical reference for pork producers, students, educators and allied industry personnel. To facilitate easier application of the principles of the guide into development and management of farm-specific swine feeding programs, a software program was developed. This spreadsheet-based program contains both a swine nutrient recommendations estimator and a least cost diet formulator. Individuals have the ability to enter individual farm performance data, including body weight, growth rate, dietary energy density, feed intake, litter size and performance, and/or body condition dependant on phase of production. From these inputs, dietary nutrient recommendations are generated and provided for utilization in the least-cost diet formulator. Users may use recommended nutrient values or input their own preferred values. Ingredients may be chosen from a customizable feed library of over 200 feed ingredients. Features include the ability to easily incorporate use of enzymes, such as phytase, and other feed additives, such as ractopamine. Emerging nutritional concepts and formulation strategies, such as use of net energy and digestible or available phosphorus, have been incorporated into the model. Printable reports provide nutrient summaries, mixing sheets, and other reports to enhance ease of use. This computer software will allow for direct application of the contents and recommendations of the NSNG, assisting users in developing economical diets and incorporating them into appropriate swine feeding programs. Appreciation is extended to the United Soybean Board for providing outreach support for the project.

Key Words: swine, nutrition, software

68 Determining optimal culling parity in commercial swine breeding herds. C. E. Abell*¹, K. J. Stalder¹, G. F. Jones², L. A. Karriker¹, A. K. Johnson¹, and J. W. Mabry¹, ¹*Iowa State University, Ames*, ²*Western Kentucky University, Bowling Green*.

The objective of this study was to determine optimal culling parity for commercial sow herds. A spreadsheet was used to estimate the economic value of the genetic lag. The culling rate, generation interval, assumed genetic improvement and economic values for each trait can be changed. The traits included were number born alive (NBA), 21-day litter weight (W21), and days to market (D113). Backfat was not included in the spreadsheet because little backfat genetic improvement is occurring in most commercial maternal lines. The NBA and W21 was expressed in the sow. The value of the genetic lag was calculated by multiplying the progress per generation by the number of generations that have passed between (1) gilt entry, (2) culling from the breeding herd and (3) the economic value for the traits. D113 is expressed in the sow and her offspring. Genetic improvement rate (GIR) was calculated by; $GIR = \text{time (in d) that had passed between gilt entry into the breeding herd} \times \text{the number of offspring marketed per parity} \times \text{the economic value of the defined trait}$. Summing these calculations across traits yields provides the total genetic lag value. Value of the genetic lag between sows in the herd and available replacement gilts assuming a 1.5 yr generation interval was calculated for P1 through P15. The genetic improvement assumed for the traits was 0.3 pigs born alive, 1.36kg at a 21d litter weight, and 3.0d to market. The economic values assigned to these traits were \$22.00/pig, \$1.54/kg, and \$0.17/day, respectively. The parity where the genetic value exceeds gilt development variable costs represents the optimal culling parity. The values ranged from \$9.06 at P1 to \$217.90 at P15. The value of the genetic difference for a sow retained in the breeding herd for 5 parities compared to a replacement gilt was \$48.27. When the genetic improvement for the traits was halved, the values ranged from \$2.31 to \$57.06 for P1 to P15. In conclusion, a sow should not be replaced by a gilt solely to improve the genetics of the herd. The value of the genetic improvement does not justify the costs associated with the development of a replacement gilt.

Key Words: culling, gilt, sow

69 Birth weight impacts the likelihood of pigs being full value prior to finishing barn closeout. J. S. Fix*¹, J. P. Cassady¹, J. W. Holl², W. O. Herring², M. S. Culbertson², and M. T. See¹, ¹*North Carolina State University, Raleigh*, ²*Smithfield Premium Genetics Group, Rose Hill, NC*.

The ability of a pig to reach full value is dependent on survival, sufficient growth to reach minimum market weight requirements, and acceptable quality. The objective of this study was to determine the impact of birth weight on likelihood of pigs being full value prior to finishing barn closeout. During a 4-wk period at a commercial farm, pigs (n = 5727) born from Large White x Landrace sows (n = 463) bred to Duroc boars were individually identified and weighed (BWT) within 24 h of birth. Pigs were weaned in 4 groups and all groups were tracked through finisher placement. Only weaned groups 2 and 3 were used after finisher placement. During BW collection at 16-wk post-finisher placement, pigs were given a visual quality score (3 = acceptable weight and health; 2

= somewhat light weight and/or minor injury; 1 = severely lightweight and/or injury). Individual survival was tracked for three phases (pre-weaning, nursery, and finishing). Individual full value (FV) was a binary trait determined at 16-wk post-finisher placement by survival, >70 kg BW, and quality score of 2 or 3. Weight at 16-wk post finisher placement (BW16) was fit to a model with linear and quadratic BWT regressions. Quality scores, survival and FV were analyzed using the Glimmix Procedure of SAS with linear BWT regressions. Linear and quadratic effects of BWT on BW16 (43.4 ± 8.7 kg, $P < 0.01$; -9.8 ± 2.8 kg; $P < 0.01$) were observed; as BWT increased BW16 increased at a decreasing rate. Survival and quality score results are presented as odds ratios. Increased BWT resulted in greater odds of pre-weaning survival (13.32; $P < 0.01$) and nursery survival (2.98; $P < 0.01$), but did not ($P > 0.05$) result in increased survival during finishing; however, data were censored as few light birth weight pigs survived until finishing. As BWT increased pigs were more likely to be acceptable quality score (3.70; $P < 0.01$). An increase in BWT increased the odds of a pig being FV prior to finishing barn closeout (6.91; $P < 0.01$). Reduced birth weight resulted in decreased chance of a pig being full value due to reduced growth, quality, and likelihood of survival.

Key Words: pigs, birth weight, full value

70 Energy use in pig production: An examination of Iowa systems. P. J. Lammers*, M. D. Kenealy, J. B. Kliebenstein, J. D. Harmon, M. J. Helmers, and M. S. Honeyman, *Iowa State University, Ames*.

This project quantified non-solar energy use in the construction and operation of different types of pig production systems in Iowa. In general producing Iowa pigs in 2009 requires nearly 85% less non-renewable energy compared to 1975. Modern U.S. pig production also compares favorably with recent assessments of European pig production in terms of non-solar energy use. The baseline system considered was a farrow-to-finish operation that produces 15,600 market pigs/yr using confinement facilities and a corn-soybean rotation. Modern pig diets typically include synthetic lysine and exogenous phytase. The baseline system represents the majority of current pork production systems in Iowa and the Midwest U.S. An alternative system that uses hoop barns for gestating sows and grow-finish pigs was also examined. The baseline system for swine production in Iowa is estimated to require 5.5 MJ non-solar energy/kg of live weight pig produced. The alternative system that uses hoop barns for grow-finish pigs and gestating sows would require 5.6 MJ non-solar energy/kg live weight. For all scenarios considered, growing and processing swine feed was the largest contributor to non-solar energy use. Energy use for pig production is influenced by crop sequence and diet strategy with nitrogen management being a critical junction among pigs, feed, and crop sequence. Using bedded hoop barns for gestating sows and grow finish pigs requires less energy to heat and ventilate buildings but more energy to grow and process feed than conventional systems. The total energy used for both housing systems is very similar. Constructing and operating facilities accounts for 25-40% of the total non-solar energy use for raising pigs in Iowa and must be included in comprehensive assessments of pig production.

Key Words: energy use, pig production, life cycle assessment

Extension - Swine Poster Session

71 Evaluation of alternative methods to analyze pig body weight data from animal sorting technologies. A. Schinckel^{*1}, M. Wastell², M. Einstein¹, J. Hubbs¹, and P. Preckel¹, ¹Purdue University, West Lafayette, IN, ²Gro-Master Inc., Omaha, NE.

Methods to analyze pig BW data collected by an animal sorting technology scale without individual pig identification were evaluated. Data were obtained for five grow-finishing groups of pigs from a commercial producer. The daily BW data were ranked and sorted into three alternative numbers of groups: percentile (100 groups), one-half percentile (200 groups) and the number of pigs. Within each replicate, the BW data were fitted to alternative versions of the Bridges function. The best model based on AIC and RSD values had the form $BW_{i,t} = C(1 - \exp(-\exp M^t)^A) + c_i(1 - \exp(-\exp M^t)^A)^D + \text{birth BW} + e_{i,t}$. The best fit of the BW data was by sorting the daily BW data into 200 one-half percentile groups based on RSD values. The mean number of BW observations/pig/d were different ($P < 0.01$) for the 5 replicates ($P < 0.91$, 3.51, 3.34, 3.38, 2.73 and 5.31 for replicates one to five, respectively). There were substantial differences ($P < 0.001$) in the mean ADG and pattern of BW growth (age by replicate interaction for ADG, $P < 0.01$) for the five replicates. A simple method of forecasting based on the current BW, current age and overall growth curve will not accurately project the age in which pigs will achieve their target market BW. Methods combining the overall BW growth curve with the early BW growth of the current group of pigs could be developed. Directly modeling the growth of BW percentiles greatly facilitates the assessment of marketing strategies when animals are sold in batches by weight.

Key Words: mixed effects model, nonlinear growth functions, swine growth

72 Analyses of lactation feed and energy intakes for three breeds of sows. A. Schinckel^{*1}, C. Schwab², V. Duttlinger³, and M. Einstein¹, ¹Purdue University, West Lafayette, IN, USA, ²National Swine Registry, West Lafayette, IN, ³Tempel Genetics, Gentryville, IN.

Daily feed intake of 993 lactation records from three breeds of sows (Duroc, Landrace and Yorkshire) were evaluated over a 19-month period. Mixed models were evaluated for the Bridges, negative exponential and generalized Michaelis-Menten (GMM) functions. The GMM function with two random effects provided the best fit to both daily feed intake (RSD = 0.93 kg/d, $R^2 = 0.831$) and ME intake (RSD = 3.04 Mcal/d, $R^2 = 0.832$). Duroc sows had less ($P < 0.001$) feed and ME intakes than Landrace and Yorkshire sows. Feed and ME intakes were less ($P < 0.001$) for the summer season (June 15 to September 15) than the other three seasons. Predicted mean ME intake (d 1 to 19) had significant ($P < 0.001$) relationships with number weaned (NW) (ME intake, Mcal/d = $16.84 + 1.445 \text{ NW} - 0.0692 \text{ NW}^2$) and 21-d litter weight (ME intake (Mcal/d) = $21.42 + 0.0454$ (21-d litter weight, kg)). Sows with greater than average 21-d litter weights consumed only 12 to 14% of the additional ME required for the additional predicted milk production. A transient reduction in feed intake was defined as when daily feed intake was 1.6 RSD less than the predicted daily feed intake for two or more days. The incidence of transient reductions in feed intake was not affected ($P > 0.10$) by stage of lactation (68 early, 77 mid and 82

late lactation). The incidence of transient reductions in feed intake was affected ($P < 0.05$) by season with incidence rates of 18.8, 16.3, 22.2 and 16.3% for summer, fall, winter and spring.

Key Words: sows, lactation, feed intake

73 Development of a stochastic model of pig growth to evaluate the impact of birth and twenty-one day body weight on pig compositional growth. A. Schinckel^{*1}, M. Einstein¹, S. Jungst², C. Booher², T. Stewart¹, and S. Newman², ¹Purdue University, West Lafayette, IN, ²PIC North American, Hendersonville, TN.

A stochastic pig growth model was developed to reproduce the non-linear relationships between birth, weaning and nursery-exit BWs to later grow-finish BWs, body composition, and lysine requirements. Serial grow-finish BW measurements of barrows (N = 836) and gilts (N = 837) were fitted to mixed model Generalized Michaelis-Menten (GMM) equations. Two random effects of the GMM equations were predicted as functions of birth and 21-d weaning BW. A population of pigs was created to reproduce the variances and covariance of the random effects of the GMM function. The protein and lipid mass of each pig was predicted from serial real-time ultrasonic backfat and loin depth measurements. Predicted protein and lipid mass data of the barrows and gilts were fitted to functions of BW which included pig specific random effects. The random effects for protein mass were fitted to regression equations including birth BW, 21-d BW, 55-d BW and parameters of the GMM function. Birth BW, BW at the inflection point of the GMM function and 55-d BW ($P < 0.05$) accounted for 6.4% of the variation in random effects for protein mass in gilts. Birth BW and BW at the inflection point ($P < 0.05$) of the GMM function accounted for 4.8% of the variation in random effects for protein mass of the barrows. Serial BW and ultrasonic measurements can be used to develop stochastic models that reproduce variation in BW growth and composition.

Key Words: pig growth, stochastic model, composition

74 Role of small livestock in poverty reduction and livelihood improvement: Rural Ugandan farmers' experience. A. Ampaire^{*} and M. F. Rothschild, Iowa State University, Ames, IA.

Iowa State University and a Ugandan development organization, in partnership since 2004, have been working to improve the livelihoods of rural households in Kamuli, Uganda. A livestock program was established to utilize livestock as a resource to combat hunger and malnutrition and to raise household incomes through farmer support and training. A study was conducted to measure the program's impact and the farmers' experiences with rearing small livestock (pigs, goats, chicken) in relation to livelihood improvement. Personal interviews were conducted with 113 Ugandan farmers who were categorized into 3 groups (G1, G2 and G3). Data were analyzed using PASW statistics software. The first group (G1, n=40) had previously been trained in animal management and 87% of them had received animals from the program. The second group (G2, n=33) had been trained by members of G1, and 93% of them

had received animals from the program. The third group (G3, n=39) had no special training and had received no animals from the program. There was no difference in the overall number of animals reared by the three groups. Many farmers in each group had 2 goats (33% G1, 25% G2, 21% G3) and no pigs (48% G1, 36% G2, 58% G3). Many farmers had less than 10 chickens (19% G1, 58% G2, 64% G3) and only a few members of G1 and G2 had more than 30 chickens. The reasons why chicken were reared differed between groups ($P < 0.05$), as G1 reared chickens mostly for food and income while G2 and G3 reared chicken mostly to meet their basic daily needs. There was no difference in the

reasons for rearing goats and pigs. There was a difference in animal sales among groups ($P < 0.05$), as G1 sold more animals. More members of G1 than G2 or G3 felt that their households consumed enough livestock products ($P < 0.001$). All groups consumed more home grown livestock products than purchased products and reported that livestock rearing had improved their livelihoods. Supporting rural farmers in Kamuli with animals and training in animal management had a positive effect on their livelihoods.

Key Words: livestock, development, livelihoods

Graduate Student Oral Competition-M.S.

75 Relative efficiency of completely randomized and randomized complete block designs in swine growth trials. N. W. Shelton*, S. S. Dritz, M. D. Tokach, R. D. Goodband, J. L. Nelssen, J. M. DeRouchey, and L. W. Murray, *Kansas State University, Manhattan*.

Randomized complete block (RCBD) designs are frequently used in swine growth experiments; however, blocking pigs by uniform BW groups reduces the error degrees of freedom compared to a completely randomized design (CRD). Thus, our objective was to directly compare the efficiency of a CRD and RCBD for detecting differences in performance due to dietary treatments. A total of 256 weanling pigs (6.3 kg BW) were used in a 28-d trial. Two diets were fed with or without growth promoters (antibiotics and zinc oxide). Weaned pigs were allotted to the 2 designs such that each design would have equal mean and variation of BW for all pigs. Pigs assigned to the CRD were allotted so that average BW and within-pen variation of BW were similar between all pens. Pigs in the RCBD were blocked by BW and placed in location blocks. There were 8 replications of each diet in each design and 8 pigs per pen. From d 0 to 28, variation of BW within pen remained the same in the CRD at 20%, but increased from 3 to 10% for the RCBD. Data was analyzed using two statistical models. The first model evaluated dietary treatment and experimental design in a 2×2 factorial and found no interactions between diet and design or differences in pig performance between designs ($P > 0.07$). The second model evaluated each design independently. Growth promoters increased ($P < 0.001$) ADG (387 vs 319 g) and ADFI (526 vs 446 g) and improved ($P < 0.03$) G:F (0.74 vs 0.72) in the CRD and increased ($P < 0.02$) ADG (372 vs 326 g) and ADFI (516 vs 448 g) in the RCBD. Standard errors for the difference were lower for ADG and G:F in the CRD than in the RCBD. The overall σ^2_{error} ratios of the CRD to RCBD were 0.67 for ADG, 1.70 for ADFI, and 0.23 for G:F. When compared with an F-test, these ratios were well below the upper critical limit of 4.6 indicating that blocking was not an effective use of degrees of freedom. Therefore, the greater degrees of freedom for the error term in CRD allow greater power to detect treatment differences.

Key Words: allotment, experimental design, pig

76 Effects of feeding diets containing bacitracin methylene disalicylate (BMD) to heat stressed finishing pigs. R. Song*, D. N. Foster, and G. C. Shurson, *University of Minnesota, St. Paul*.

The objective of this study was to evaluate the effects of heat stress and adding BMD to a diet containing 10% dried distiller's grains with solubles (DDGS) on growth performance, carcass characteristics, physiological parameters, and gut health of pigs. Four groups of 32

mixed sex finishing pigs (n = 128) with initial BW between 80 to 90 kg were used in this study. Pigs were assigned randomly to diets and temperature treatments in a 2×2 factorial arrangement. Pigs were fed a corn-soybean meal based control (CON) or BMD (31.5 ppm) diet and exposed to a constant thermal neutral temperature (23°C) or a cyclical heat stress environment (37°C from 1000 h to 1900 h and 27°C from 1900 h to 1000 h) for 28 days. Each group of pigs was kept in 4 rooms with 2 pens/room and 4 pigs/pen. Saliva samples from each pig were collected on d -1 (initial baseline), d 1, 13, and 27 for cortisol analysis. Haptoglobin (Hp), IL-1 β and TNF- α concentrations were determined in serum collected from one barrow per pen on d -1, 1, 13, and 27. Pigs exposed to heat stress had 31% lower ADG ($P < 0.0001$), 23% lower ADFI ($P < 0.0001$), 9% lower G:F ($P < 0.001$), and 34% higher average daily water intake ($P = 0.03$), compared with pigs housed in the thermal neutral environment. Dietary BMD did not improve growth performance of pigs. Heat stress increased ($P < 0.05$) saliva cortisol in pigs on d 1, but no effects were observed on subsequent days. Serum Hp levels were not different between dietary treatments, but heat-stressed pigs showed a higher ($P < 0.05$) level of Hp on d 1, and levels tended to remain high ($P < 0.1$) on d 13. Pigs fed the BMD diet tended to have greater villus height ($P = 0.07$) and crypt depth ($P = 0.09$) in the duodenum, and greater crypt depth in the jejunum ($P = 0.07$). Pigs housed under heat stress conditions tended to have a lower proportion of propionate ($P = 0.08$), greater acetate:propionate ratio ($P = 0.08$), and a lower proportion of valerate ($P = 0.02$) in the cecum. These results suggest that heat stress reduces pig growth performance and impacts the pig's immune system and gut health.

Key Words: heat stress, finishing pig, antibiotic

77 Effect of chronic exposure of low levels of aflatoxin and deoxynivalenol on growth and immune status of pigs. A. C. Chaytor*¹, M. T. See¹, J. A. Hansen², A. L. De Souza², T. Middleton³, and S. W. Kim¹, ¹North Carolina State University, Raleigh, ²Murphy-Brown LLC, Rose Hill, NC, ³Ag ProVision LLC, Kenansville, NC.

This study investigated the growth and immune responses of pigs fed diets with low to moderate concentrations of aflatoxin (AF) and deoxynivalenol (DON) from naturally contaminated corn. Sixty gilts (13.9 \pm 0.2 kg BW) were randomly assigned to 4 treatments (5 replicates per treatment and 3 pigs per pen): A (pigs fed a control diet without detectable AF and DON); B (pigs fed a diet with 60 AF and 300 μ g/kg DON); C (pigs fed a diet with 120 AF and 600 μ g/kg DON); and D (pigs fed a diet with 180 AF and 900 μ g/kg DON). Pigs were fed diets ad libitum for 33 d. Feed intake and BW were measured weekly, and pigs were bled (8 mL) through the jugular vein on d 33 to measure the

numbers of blood cells, to conduct liver function test, and to measure immunological parameters including IgG, IgM, TNF α , IFN γ , IL-4, and IL-6. One pig representing the average BW of each pen was euthanized to obtain liver, kidney, and spleen for tissue color measurement and histological evaluation of tissue damage. Pigs in C and D tended to have smaller ADG ($P = 0.058$, 0.43 and 0.41 vs. 0.52 kg/d) and ADFI ($P = 0.061$, 0.92 and 0.88 vs. 1.04 kg/d) when compared with the control. White blood cell number (10^3 cells/ μ L) of pigs in D (23.4) was greater ($P < 0.05$) than those in A (18.4), B (18.5), and C (16.8). Serum TNF α concentration (pg/mL) of pigs in D (335) was greater ($P < 0.05$) than those in A (299) and C (290). Pigs in B and D had greater ($P < 0.05$) fibrosis in liver tissues than those in A. Collectively this study shows that diets containing AF greater than 60 μ g/kg and DON greater than 300 μ g/kg may reduce growth due to decreased feed intake, whereas diets containing AF (greater than 120 μ g/kg and DON greater than 600 μ g/kg may result in altered immune health, systemic inflammation, and partial liver damages causing further reduction in growth of pigs.

Key Words: aflatoxin, deoxynivalenol, pigs

78 Estimates of energy utilization and maintenance requirements of pigs selected for residual feed intake. N. Boddicker*, N. Gabler, M. Spurlock, D. Nettleton, and J. C. M. Dekkers, *Iowa State University, Ames.*

To investigate the genetic and biological basis of residual feed intake (RFI), a measure of feed efficiency, a line of Yorkshire pigs was selected for reduced RFI. The objective of this study was to evaluate the 5th generation of this 'select' line against a randomly selected control line for carcass energy utilization and overall efficiency during early (EGP) and later (LGP) growth phases. For each growth phase, 40 barrows from each line were paired by age (~65 and 132 d for EGP and LGP) and weight (23.9 ± 4.2 and 74.8 ± 9.9 kg) and randomly assigned to 1 of 4 feeding treatments in 8 replicates: 1) ad libitum (AD); 2) 75% of AD (AD75); 3) 55% of AD (AD55); and 4) weight stasis (WS), with weekly adjustments to intake to keep each pig's body weight constant. Pigs were individually penned and on treatment for 6 weeks. Carcass energy content at the end of the test period was determined by adiabatic bomb calorimetry and regressed on feed energy consumed to estimate maintenance requirements and feed efficiency above maintenance. Initial body weight, backfat, and loin eye area were used as covariates to adjust for initial carcass composition. Separate regression lines were fitted for the WS versus the 3 AD treatments. Regression lines were steeper (significant at ($P < 0.05$ for LPG) for the WS than the 3 AD treatments. The select line tended to have lower slopes for the LGP ($P < 0.34$), indicating slightly lower efficiency of energy use over maintenance. For the EGP, the select line had a steeper slope ($P < 0.16$), but this was caused by one outlier AD pig. Intercepts for the WS treatment, which are estimates of maintenance requirements, tended to be greater for the select (lower maintenance requirements) than the control line but approached significance ($P < 0.13$) only for the LGP. These data suggest that the select line has slightly less efficient energy utilization above maintenance but has lower maintenance requirements, which may explain part of the difference in feed efficiency between the two lines. This research was funded by grants from the National Pork Board and the Iowa Pork Producers Association.

Key Words: residual feed intake, feed efficiency, maintenance requirements

79 Seasonal response to dried distillers grains on smooth bromegrass pastures. A. K. Watson*, W. A. Griffin, T. J. Klopfenstein, G. E. Erickson, V. R. Bremer, K. R. Brink, and W. H. Schacht, *University of Nebraska, Lincoln.*

Dried distillers grains with solubles (DDGS) are a good source of 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 ($324 \text{ kg} \pm 22 \text{ kg}$) were used in each of 5 years to measure animal and pasture performance. Treatments included pastures fertilized (FERT) with 88 kg N/ha, pastures that were not fertilized but cattle were supplemented (SUPP) at 0.6% of BW with DDGS grains daily (1.9-2.7 kg/steer/d), and control pastures (CON) with no fertilizer or supplementation. Cattle were stocked at 6.8 AUM/ha for CON and 9.9 AUM/ha for FERT and SUPP from mid April to the end of September. Interim weights were taken at the end of each of five grazing cycles (24 or 36 d in each cycle depending on forage availability). 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 and put and take cattle were adjusted to maintain similar grazing pressure among treatments. Diet collections were taken throughout the grazing season via ruminally fistulated steers to measure forage quality. In 2009 CON and FERT steers gained 0.68 kg/d ($P = 0.50$) and SUPP gained 1.08 kg/d ($P < 0.01$). Pastures did not differ in DM digestibility (DMD) so the increased gain can be explained as a response to DDGS. Interim performance shows the increased response to DDGS is not equal throughout the season. Diet DMD averaged 67.5% for cycles 1 and 2 and 55.8% for cycles 3 to 5. CON and FERT steers gained 0.95 kg/d during cycles 1 and 2 and 0.53 kg/d during cycles 3 to 5. Gains for CON and FERT steers were correlated with DMD ($R^2 = 0.66$; $P < 0.01$). Response to DDGS was 0.15 kg/d during cycles 1 and 2 and 0.33 kg/d during cycles 3 to 5 ($P < 0.01$). As DMD decreased over the grazing season the cattle response to the DDGS increased. This suggests that supplementing grazing cattle at key points in the growing season may be beneficial.

Key Words: dried distillers grains, forage, supplementation

80 Effect of cross-fostering on pre-weaning survival and weaning weight in swine. J. A. Bishop*¹, J. P. Cassady¹, J. W. Holl², W. O. Herring², M. S. Culbertson², J. S. Fix¹, and M. T. See¹, ¹*North Carolina State University, Raleigh*, ²*Smithfield Premium Genetics Group, Rose Hill, NC.*

Cross-fostering is commonly used in commercial swine production to balance number of pigs nursed per sow. The objective of this study was to estimate the effect of cross-fostering on piglet pre-weaning growth and survival in a commercial sow farm. During a 4 wk period, litters ($n = 420$) were farrowed from multiparous Large White x Landrace females mated to Duroc boars. Sows were randomly assigned to one of two treatments prior to farrowing, cross fostered (CF) or non-cross fostered (NF). Within 24 h pigs were weighed, individually identified based on treatment group, and pigs within the CF group were fostered as needed. Pigs were weaned in 4 weekly groups at 20.0 ± 2.0 d of age; 2 d prior to weaning all pigs were individually weighed and nurse sow was recorded. A model with fixed effects of treatment, nurse sow parity, and weaning group and covariates of number born alive, number weaned, and lactation length was fit using the Mixed Procedure of SAS to determine the impact of fostering on litter weaning weight. To

determine the impact of fostering on pre-weaning survival the Glimmix procedure of SAS was used to analyze a model with fixed effects of treatment and farrowing house, covariates of number born alive and litter birth weight, and litter birth weight x treatment interaction. Due to chance sows assigned to NF treatment had a tendency (NF = 11.5 ± 0.4 and CF = 10.9 ± 0.4; $P = 0.13$) for greater number born alive; consequently number born alive was included to adjust for the differences in number born alive. Litters from sows in the CF treatment were 1.5 ± 0.7 kg (CF = 51.3 ± 0.8 kg and NF = 49.8 ± 0.9 kg; $P < 0.05$) heavier at weaning than litters weaned from sows in the NF treatment. Litter survival did not differ (odds ratio = 0.98; $P = 0.83$) between treatment groups. Cross-fostering pigs resulted in a 3% increase in litter weaning weight and did not improve pre-weaning survival. It was concluded that cross-fostering was of little or no benefit to pre-weaning performance at the commercial sow unit where this experiment was conducted. Further work is planned to estimate the impact of cross-fostering on post-weaning growth and carcass merit.

Key Words: pig, cross foster, pre-weaning

81 Effects of glycerol and sire breed on growth and carcass traits of finishing wether lambs. R. Beck*, A. Wertz-Lutz, C. Wright, J. Held, R. Zelinsky, and C. Delvaux, *South Dakota State University, Brookings.*

Seventy-two market wethers were used in a 2 × 3 factorial arrangement of treatments to determine the effects of sire breed and feeding increasing amounts of glycerol on growth and carcass characteristics. By breed, (Hampshire-cross n = 36; Southdown-cross n = 36) wethers were randomly assigned to 24 pens so that the average initial BW was similar among pens within a breed (initial BW Hampshire-cross 34.7 ± 0.3 kg, Southdowns 32.2 ± 0.3 kg). Pelleted corn-soybean-based diets which included 0, 5, or 10% glycerol on a DM basis were assigned each to 4 pens within a breed. Glycerol replaced corn in the diet at 5 or 10% on a DM basis. Initial and final weights were the average of BW recorded on two consecutive days, and intermediate BW were recorded at 21-d intervals. Feed intakes were recorded throughout the trial. Lambs were harvested after 64 days on trial (final BW Hampshire-cross 57.9 ± 0.8 kg and Southdown-cross 53.4 ± 0.8 kg). Carcass data recorded after a 24-hour chill were HCW, fat thickness, body wall thickness, LM area, yield grade, and quality grade. Data were analyzed using the GLM procedure of SAS. Glycerol inclusion, sire breed, and their interaction were evaluated. Interaction of the main affects was not significant, and glycerol inclusion did not significantly influence growth or carcass characteristics. Hampshire-sired wethers had heavier BW ($P < 0.05$), and higher cumulative ADG ($P = 0.05$) when compared with Southdown-sired wethers. Hampshire-sired lambs also had heavier HCW ($P = 0.02$) and tended ($P = 0.08$) to have larger LM area than Southdown-sired lambs, whereas Southdown-sired lambs had more fat ($P = 0.01$) and higher yield grades ($P = 0.01$). Southdown-sired lambs also had a greater incidence ($P = 0.02$) of USDA Prime carcasses than Hampshire-sired lambs. Sire breed had a significant effect on growth and carcass characteristics in finishing lambs, however, inclusion of glycerol at up to 10% of the diet DM did not alter growth or carcass traits.

Key Words: carcass, glycerol, sheep

82 Impact of maternal exercise on maternal body composition, fetal growth, and umbilical blood flow in the pig. E. K. Harris*, B. J. Bartling, T. L. Neville, J. D. Kirsch, J. D. Magolski, E. P. Berg, and K. A. Vonnahme, *North Dakota State University, Fargo.*

To determine the influence of maternal exercise on body composition and potential impact on umbilical blood flow (UBF), Yorkshire gilts (n = 10) bred to a common boar were placed in gestation stalls on d 30 of gestation (d 0 = breeding). On d 40, gilts were randomly assigned to either remain in a gestation stall for the duration of pregnancy (CON) or to undergo an exercise treatment where gilts were walked for 30 min, 3 d a week until d 105 of gestation (EX). Maternal body composition [loin eye area (LEA) and 10th rib back fat (BF) determined by ultrasound (US)] and BW were recorded on d 36 and every 14 days thereafter. Fetal abdominal and biparietal widths were determined by averaging 4 fetal US measurements. Mean UBF volume [$\pi r^2 \times \text{TAM} \times 60$; where r = radius of vessel (cm²), TAM = time-averaged mean flow velocity (cm/s)], PI [(peak systolic velocity - peak end-diastolic velocity)/mean peak flow velocity], and RI [(peak systolic velocity - peak end-diastolic velocity)/peak systolic velocity] were measured using color-Doppler US (Aloka SSD-3500; Aloka America, Wallingford, CT) from 2 different fetuses from d 39 to 94 of gestation. No treatment x day interactions ($P > 0.73$) were observed for any measurements. From d 39 to 105, BW increased ($P < 0.01$; 172.2 vs. 200.2 ± 3.9 kg), LEA remained similar ($P = 0.12$) and BF decreased ($P = 0.05$; 1.76 vs 1.60 ± 0.05 cm). Exercise only affected BW with EX gilts being lighter ($P = 0.04$) compared to CON gilts (190.2 vs 182.7 ± 2.5 kg). While fetuses increased ($P < 0.01$) in abdominal and biparietal widths with advancing gestation, there was no influence of exercise on fetal growth. Percentage change of PI and RI increased ($P < 0.01$) from d 39 to 55, decreasing by d 81 ($P = 0.05$), further decreasing ($P < 0.01$) by d 95. Umbilical BF increased ($P < 0.01$) from d 39 to 67 and remained steady until d 95. There was also a treatment effect ($P = 0.02$) with EX gilts increasing UBF 679 ± 90% compared to CON gilts which increased UBF 361 ± 87%. While fetal measures of growth were not altered by maternal exercise, the observed increase in UBF may benefit postnatal growth.

Key Words: pregnancy, swine, umbilical blood flow

83 Fatty acid profiles of pork fat are altered when ractopamine (Paylean), CLA and DDGS are fed. H. L. Evans*¹, R. B. Hinson¹, G. D. Gerlemann¹, D. Pompeu¹, S. N. Carr², M. J. Ritter², B. R. Wiegand¹, G. L. Allee¹, and R. D. Boyd³, ¹University of Missouri, Columbia, ²Elanco Animal Health, Greenfield, IN, ³The Hanor Company, Franklin, KY.

This study evaluated the effects of CLA, corn distiller's dried grains with soluble (DDGS), and a ractopamine (RAC) program for 27 d prior to harvest on fat quality and calculated iodine values (IV). Pigs (TR4 × C22) (n = 1,102) were assigned in a 2 × 2 × 2 factorial arrangement via a split-split plot design. Diets were treatment combinations of CLA (0, 0.6%), DDGS (0, 20%), and RAC (0, 7.4 ppm). Pen was the experimental unit with 6 replicates/treatment for a total of 48 pens each and 23 pigs/pen. Pigs (125 ± 1.4 kg) were harvested at a commercial facility, and a random subset of five pigs per pen utilized to determine fatty acid (FA) composition of fat depots from the jowl and belly. Inclusion of

DDGS and RAC in the diets decreased the concentration of saturated FA (SFA) in the belly (35.3 to 33.5% and 35.0 to 33.8%, respectively) and jowl samples (33.4 to 32.2% and 33.4 to 32.2%, respectively). Conversely, CLA inclusion increased the percentage of SFA in belly (33.4 to 35.3%) and jowl (32.0 to 33.6%) fat. The inclusion of DDGS and CLA reduced (mono-unsaturated FA (MUFA) in belly (46.9 to 45.6% and 47.6 to 44.8%, respectively) and jowl (48.0 to 47.3% and 48.6 to 46.7% respectively) fat. The MUFA in jowl samples increased with RAC inclusion (47.3 to 47.9%). Increased poly-unsaturated FA (PUFA) were observed with DDGS and RAC in belly (17.9 to 21.0% and 18.9 to 20.0% respectively) and jowl fat (18.6 to 20.5% and 19.3 to 19.9% respectively). An increase in PUFA concentration (19.0% to 19.8%) was observed for belly fat with CLA. The IV increased with DDGS and RAC inclusion for belly fat (66.3 to 70.6 and 67.5 to 69.4 respectively) and jowl (68.4 to 71.1 and 69.1 to 70.4) samples and decreased with CLA inclusion in belly (69.0 to 67.9) and jowl (70.3 to 69.2) fat. Overall, feeding RAC decreased SFA and increased PUFA and IV in both depots. Dietary CLA increased SFA and decreased MUFA and IV in both depots.

Key Words: pork, fat quality, DDGS

84 Effects of dietary aflatoxin on performance and hepatic gene expression in swine. S. M. Rustemeyer^{*1}, W. R. Lamberson², D. R. Ledoux², K. Wells², and K. M. Cammack¹, ¹University of Wyoming, Laramie, ²University of Missouri, Columbia.

Aflatoxin B1 (AFB1) concentration can be high in commonly used feedstuffs and lead to an increased incidence of aflatoxicosis, a disease associated with decreased feed intake, reduced BW gain, and impaired liver function. The objective of this study was to determine the effects of aflatoxin on performance and hepatic gene expression of growing barrows. Duroc × Yorkshire crossbred barrows (n = 90; age = 35 ± 5 d; initial BW = 14.2 ± 3.0 kg) were randomly assigned in a 3 × 3 factorial design to receive 0 (CON), 250 ppb AFB1 (LOW) or 500 ppb AFB1 (HIGH) for 7, 28 or 70 d, after which barrows were euthanized and liver samples collected. A linear decrease ($P < 0.05$) in ADG and feed intake was observed for increasing concentrations of AFB1, with the greatest decrease observed in HIGH barrows. RNA sequencing was performed on liver samples collected on d 70 to detect changes in hepatic gene expression. This technique measures RNA abundance produced from a given genomic sequence. The number of times an mRNA is sequenced is relative to its abundance. Initial results from CON barrows (n = 3) indicate that 10% of the Ensembl unigene set were not present in d 70 liver samples. There was a 28,000 fold range of expression. Approximately 80% of the sequences had low levels of expression, fewer than 100 reads, in hepatic tissue. In contrast, 3% had 1,000 or more reads. The most abundant transcript had 280,000 reads. Repeatability of transcript copy number across the three biological replicates was 97.0%. Mean number of reads was 95.2 across all probed sequences, with a coefficient of variation of 19.8%. Genomic analysis indicates considerable variation in the number of transcripts, with most probed sequences having low levels of transcription. High repeatability of number of reads across biological replicates indicates strong power for detecting treatment differences. Greater variation is expected in comparisons between CON, LOW, and HIGH treatment groups.

Key Words: aflatoxin, gene expression, swine

85 Supplement moisture and feeding site affect feed intake and waste by wintering beef cows. J. P. Jaderborg^{*1}, S. L. Bird², G. I. Crawford³, R. Walker⁴, B. J. Funnell², and A. DiCostanzo¹, ¹University of Minnesota, St. Paul, ²North Central Research and Outreach Center, Grand Rapids, MN, ³Regional Extension Office, Hutchinson, MN, ⁴Regional Extension Office, Andover, MN.

An experiment was conducted to evaluate whether supplement moisture (11.7%, dry vs. 73.4%, wet) or placement (within a structure or on the ground) affected hay, supplement or total DMI and waste by wintering beef cows. Late gestating Angus cows (n = 54; 616 kg) were stratified by BW and age, and assigned to one of six groups. Groups were then assigned orthogonally to dietary treatments within each period in a 6 × 6 Latin Square design. Treatments included no energy supplement (Control) or supplementing corn screenings (CS) in a bunk (CS-B) or in an inverted tire (CS-T), or wet beet pulp (BP) on the ground (BP-G), in a bunk (BP-B) or in an inverted tire (BP-T). Cows were weighed after removing feed for at least 12 h to determine group BW. Dry matter and energy required for maintenance was determined from NRC (2000) requirements, and feed offered was provided accordingly. Each treatment received a complete mineral and salt source to meet daily needs for these nutrients. Refusals were measured every 24 h by collecting and weighing random 0.093 m² samples representing 2% of the waste scatter area. Hay DMI was greatest ($P < 0.05$) for cows fed no energy supplement and those fed CS-B (13.15 and 12.96 kg/d). Hay DMI was lowest ($P < 0.05$) for cows fed BP-T and BP-B (10.94 and 10.31 kg/d). Consumption of hay DM by cows fed BP-T was similar ($P > 0.05$) to that of cows fed BP-G (11.58 kg/d), and consumption of hay DM by cows fed BP-G and those fed CS-T was similar (11.97 kg/d). Expressed as a percentage of total DMI, cows fed BP-B wasted the most ($P < 0.0001$) hay (18.1%). Within BP, cows fed on the ground consumed the least ($P < 0.0001$) supplement DM (3.1 kg/d); thus, they had the greatest supplement waste (21.8%). Cows fed CS completely consumed their supplement. Cows consuming BP-B, CS-B, BP-T or BP-G had the greatest ($P < 0.02$) total DMI (13.87, 14.24, 14.48, or 14.59 kg/d, respectively). The greatest ($P < 0.01$) DM waste (13.9%) occurred with cows fed BP-G or BP-B. Using a high-moisture supplement increased hay waste and reduced hay DMI. Beet pulp fed on the ground led to greater supplement waste, while BP fed in a bunk led to greater hay waste.

Key Words: cow, supplement, intake

86 Prediction of carcass traits and fat-free lean using ultrasound measures at the last rib and tenth rib in swine. R. O. McKeith^{*}, B. K. Lowe, J. A. Safko, R. M. Pitzer, J. R. Segers, A. M. Stelzleni, M.J. Azain, and T. D. Pringle, University of Georgia, Athens.

Real-time ultrasound (US) measurements for LM area (LMA), LM depth (LMD), and fat depth at the 10th rib (TR) and last rib (LR) were collected on a group of commercial finishing pigs (n = 59) in order to evaluate the ability of these measures to predict carcass fat-free lean (FFL). Pigs were fed a corn/soybean meal diet and harvested at an approximately 128.5 kg. On the day prior to harvest, a cross-sectional US image, for measuring ULMA and UBF depth, and three longitudinal US scans (7 cm off the midline), for measuring ULMD and UBFL depth, were collected at the TR and LR. A trained US technician collected and interpreted the images using Swine Image Analysis software (Designer

Genes, Inc.). Pigs were harvested, under inspection, hot carcass weight (HCW) was recorded, and FLMD and FBF depth at TR and LR was measured with a portable Fat-O-Meater (FOM; SFK Technology). After a 24-h chill (-2C), carcass LMA and BF depth were measured at the TR and LR. Carcass LMA and BF depth at the TR, along with HCW, were used to calculate FFL. Correlations between carcass LMA, BF, and FFL and US and FOM measures were calculated. The ability of the US and FOM measures to predict FFL was determined through regression analysis. For TR and LR, strong correlations ($P < 0.01$) existed between US and FOM fat measures and similar carcass measures ($r > 0.84$; $P < 0.01$). For LM, US measures at the LR were more highly correlated to carcass LMA than FOM and TR muscle measures. All fat measures were highly correlated to carcass FFL ($r > 0.79$; $P < 0.01$); however, the only highly correlated muscle measure was TR FLMD ($r = 0.80$; $P < 0.01$). In regression analysis, cross-sectional US measures at the LR and TR (ULMA and UBF) accounted for the greatest amount of variation in carcass FFL ($R^2 = 0.79$ and 0.75 , respectively). In contrast, FOM measures accounted for the least amount of variation in carcass FFL ($R^2 = 0.63$ and 0.67 for LR and TR, respectively). These data show that US measures of fat and muscle, collected immediately prior to harvest, are equally or more effective in predicting carcass FFL than current industry methods using the FOM.

Key Words: pork, ultrasound, fat-free lean

87 Effects of formulating diets for weanling pigs on a standardized total tract digestibility (STTD) of P basis. F. N. Almeida* and H. H. Stein, *University of Illinois, Urbana*.

Two experiments were conducted to test the hypothesis that pigs fed diets that are equal in standardized total tract digestible (STTD) P will

perform equally well regardless of the total P concentration in the diets, and that the addition of microbial phytase, distillers dried grains with solubles (DDGS), or a combination of phytase and DDGS will result in a reduction in P excretion from the pigs. Diets were formulated on the basis of the STTD of P for each ingredient that had been measured in a previous experiment. Four corn-soybean meal (SBM) based diets were formulated to contain 0.32% STTD P and used in a 2 x 2 factorial design with 2 levels of phytase (0 or 500 units/kg; Optiphos 2000, Enzyvia, Sheridan, IN) and 2 levels of DDGS (0 or 20%). Dicalcium phosphate (DCP) was included in the diets at levels of 1.15 and 0.35% (corn-SBM diets without and with phytase, respectively), and 0.65 and 0% (corn-SBM-DDGS diets without and with phytase, respectively). In Exp. 1, 160 pigs (initial BW: 11.25 ± 1.95 kg) were fed the 4 diets for 21 d and results showed that inclusion of phytase in the diet containing no DDGS tended ($P \leq 0.10$) to decrease G:F, but inclusion of 20% DDGS to the diets tended ($P \leq 0.10$) to increase ADG, ADFI, and final BW. In Exp. 2, 24 pigs (initial BW: 14.6 ± 1.4 kg) were placed in metabolism cages and fed the 4 diets that were used in Exp. 1. Feces and urine were collected quantitatively for 5 d after a 5 d adaptation period. The apparent total tract digestibility (ATTD) of P increased ($P \leq 0.01$) from 56.1 to 71.5% in the corn-SBM diet and from 62.3 to 74.1% in the corn-SBM-DDGS diet when phytase was added to the diet. The inclusion of DDGS to the corn-SBM diet also increased ($P \leq 0.01$) the ATTD of P. Phytase, DDGS, or the combination of phytase and DDGS, reduced ($P \leq 0.01$) P excretion. In conclusion, diets for weanling pigs may be formulated based on STTD values for P without compromising pig performance, and the combination of phytase and DDGS eliminates the need for the inclusion of DCP in the diet. Dietary phytase, DDGS, and the combination of phytase and DDGS will reduce P excretion from weanling pigs.

Key Words: excretion, phosphorus, pigs

Graduate Student Oral Competition-Ph.D.

88 Insoluble dietary fiber expedites recovery from colibacillosis diarrhea in pigs after weaning. V. Perez*¹, C. Maddox¹, G. Fahey, Jr.¹, J. Pluske², and J. Pettigrew¹, ¹*University of Illinois, Urbana*, ²*Murdoch University, Murdoch, Australia*.

To determine whether the soluble (SDF) or insoluble (IDF) dietary fiber, or their absence from the diet, helps in the recovery from colibacillosis diarrhea, an experiment was conducted with 80 newly weaned pigs (21 d of age and 7.33 ± 0.21 kg of BW). The study was a randomized complete block design with a factorial arrangement of 4 diets x 2 challenge treatments: with or without F18 β -hemolytic LT STb SLT2 *E. coli* (10^{10} cfu/dose). Blocks were 2 replicates of the experiment. The experimental unit was the pig. Diets were: 1) typical weaning diet without animal plasma (C); 2) C diet + pectin (S); 3) C diet + cellulose (I); 4) semi-purified corn starch-casein based diet with no dietary fiber (N). Diet S had 8% more SDF, and diet I had 8% more IDF than the C diet. Diets were fed from weaning. Inoculation began on d 5 after weaning (post-inoculation [PI] d 0) and consisted of 1 daily dose of distilled water or the *E. coli* (EC), delivered orally during 3 consecutive days. Diarrhea was scored from 1 = normal feces, through 5 = watery diarrhea. Intestinal tissue samples of 5 pigs/treatment were collected on PI d 5 and 10. Inoculation with EC reduced ($P < 0.001$) ADG from PI d 0 thru 5 (153 vs. 85 g/d; SEM = 21) regardless of diet, and increased ($P < 0.05$) diarrhea from PI d 1 thru 10. Pigs fed the N diet did not defecate daily and had less diarrhea

(Table 1); pigs fed the I diet showed less diarrhea from PI d 9. More ($P < 0.01$) lymphocytes infiltrated the ileal mucosa layer of EC pigs on PI d 5. On PI d 10, crypt depth of the colon was increased ($P < 0.05$) in EC pigs, and reduced ($P < 0.05$) by the N diet. Addition of IDF to the C diet expedited the recovery from colibacillosis diarrhea.

Table 1. Main effect of diet on diarrhea score.

Diarrhea score, PI d	Diet C	Diet S	Diet I	Diet N	SEM	P-value
1	1.80	1.40	1.90	1.55	0.23	0.42
2	2.25	2.01	2.35	1.85	0.30	0.60
3	2.85 ^a	2.49 ^a	2.40 ^a	1.75 ^b	0.24	0.01
4	2.57 ^a	2.73 ^a	2.87 ^a	1.82 ^b	0.45	0.03
5	2.75	2.68	2.65	1.95	0.27	0.10
6	2.70 ^a	3.10 ^a	2.50 ^{ab}	1.80 ^b	0.31	0.04
7	2.70	2.80	2.60	1.90	0.33	0.22
8	2.90 ^a	2.70 ^a	2.00 ^{ab}	1.50 ^b	0.34	0.02
9	2.58 ^a	2.68 ^a	1.68 ^b	1.18 ^b	0.32	0.002
10	2.18 ^{ab}	2.29 ^a	1.29 ^c	1.49 ^{bc}	0.29	0.03

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

Key Words: colibacillosis diarrhea, insoluble fiber, soluble fiber

89 Effect of selection for residual feed intake on sow reproductive performance and efficiency. J. M. Young^{*1}, R. Bergsma², E. Knol², J. F. Patience¹, and J. C. M. Dekkers¹, ¹*Iowa State University, Ames*, ²*Institute for Pig Genetics, Beuningen, the Netherlands*.

Feed efficiency is of increasing importance in the swine industry. When developing strategies for genetic improvement of feed efficiency, it is important to evaluate correlated responses to selection. Using unique lines of pigs that have been developed at Iowa State University, the objective of this experiment was to evaluate sow reproductive performance and lactation efficiency in two lines of Yorkshire pigs, one which was selected over 6 generations for decreased RFI (select line) and a control line which was randomly selected for four generations and then for increased RFI. After 6 generations, the select line had two more piglets farrowed ($P < 0.01$), one more piglet born alive ($P < 0.1$), heavier piglets at birth and weaning ($P < 0.05$), and piglets which had greater pre-weaning growth rates ($P < 0.05$), with no difference in number of piglets weaned ($P = 0.77$). However, this increased reproductive performance for the select line was at a cost to the sow; with no differences in body weight or composition at the start of lactation (estimated from ultrasonic backfat), the select line lost more weight and fat mass during lactation ($P < 0.0001$). The select line consumed significantly less feed during lactation only in generation 6 ($P < 0.001$). Energy output in the form of piglets was higher ($P < 0.05$) in the select line when adjusted for energy input above maintenance requirements from feed intake and body mobilization. However, lactation efficiency, a ratio of output to input, did not differ between the two lines. In conclusion, selection for RFI has positively affected litter sizes and pre-weaning growth but has negatively affected sow body condition change during lactation. Funding provided by the National Pork Board, the Iowa Pork Producers Association, and National Needs Fellowship grant no. 2007-38420-17767.

Key Words: swine, residual feed intake, reproduction

90 Comparison of choice white grease and soybean oil for finishing pigs. Y. Liu^{*}, D. Y. Kil, V. G. Perez-Mendoza, and J. E. Pettigrew, *University of Illinois, Urbana*.

A recent report showed higher swine NE for choice white grease (CWG) than for soybean oil (SBO). The present study was conducted to determine whether practical responses of finishing pigs would verify that difference. Pigs ($n = 135$, 64.8 ± 6.2 kg BW) were randomly assigned to 5 dietary treatments: 1) a corn-soybean meal diet without added fat (C), 2) C + 3% SBO, 3) C + 6% SBO, 4) C + 3% CWG, and 5) C + 6% CWG. The pigs were in 9 replications with 3 pigs/pen. There were 2 diet phases, d 1 – 21 for phase I and d 21 – 49 for phase II. Dietary treatments within each phase were formulated to contain equivalent standardized ileal digestible lysine/Mcal of ME. The ADG, ADFI and G:F were measured during each phase and overall. At the beginning and end of this experiment, ultrasound was used to measure backfat depth at the last rib (BFLR) and 10th rib (BFTR), and muscle depth at the last rib (MDLR) and 10th rib (MDTR). The changes of BFLR, BFTR, MDLR, and MDTR between initial and final measurements were calculated. Pigs fed fats had significantly higher ($P < 0.05$) G:F in phase I (0.41 vs. 0.38), phase II (0.33 vs. 0.30) and overall (0.36 vs. 0.33), lower ($P = 0.05$) ADFI (3.33 vs. 3.54 kg/d) in phase II, and tended ($P = 0.06$) to have more increase in BFLR than pigs fed the control diet. Pigs fed 6% fats had higher ($P < 0.01$) G:F in phase II (0.35 vs. 0.32) and overall (0.38 vs. 0.35) than pigs fed 3% fats. Pigs fed CWG had higher ($P < 0.05$) ADG (1.28 vs. 1.19

kg/d) and G:F (0.42 vs. 0.40) in phase I than pigs fed SBO. Compared to SBO, CWG enhanced ($P < 0.05$) the increase in MDTR. In phase I, increasing CWG from 3% to 6% increased ADG and G:F, but the direction was opposite with SBO (interaction, $P < 0.05$). In conclusion, these results support a greater energy value for CWG than for SBO.

Key Words: soybean oil, choice white grease, growing-finishing pigs

91 Innate immune responses of bovine mammary epithelial cells triggered by toll-like receptor signaling are enhanced by 1,25-dihydroxyvitamin D₃. C. D. Nelson^{*1,2}, T. A. Reinhardt², D. C. Beitz¹, and J. D. Lippolis², ¹*Iowa State University, Ames*, ²*National Animal Disease Center, USDA, Ames, IA*.

We have recently shown that 1,25-dihydroxyvitamin D₃ (1,25(OH)₂D₃) plays an important role in the bovine innate immune response. 1,25(OH)₂D₃ is the active vitamin D metabolite and is produced from the major circulating metabolite, 25-hydroxyvitamin D₃, by the enzyme 1 α -hydroxylase (1 α -OHase). Bovine monocytes express 1 α -OHase in response to toll-like receptor (TLR) recognition of bacteria and we have evidence that 1 α -OHase is expressed in mammary tissue during mastitis. Production of 1,25(OH)₂D₃ by 1 α -OHase in activated monocytes amplifies the expression of inducible nitric oxide synthase (iNOS) and the chemokine RANTES. Mammary epithelial cells (MEC) have been shown to express iNOS and RANTES in response to TLR signaling, but the effects of 1,25(OH)₂D₃ on expression of iNOS, RANTES, and other vitamin D responsive genes in MEC were not known. The objective of this experiment was to determine the effects of 1,25(OH)₂D₃ and lipopolysaccharide (LPS) on iNOS, RANTES, and S100 calcium binding protein A12 (S100 A12) gene expression in bovine MEC. Primary cultures of MEC were derived from mammary biopsies of Holstein cows in mid-lactation. To determine the effects of 1,25(OH)₂D₃ and LPS on MEC, cultures were treated with 0, 0.1, 1, or 10 nM 1,25(OH)₂D₃ along with 0 or 1 μ g/mL lipopolysaccharide (LPS) for 16 hours. Gene expression was measured by real-time PCR. In MEC stimulated with LPS, expression of iNOS and S100 A12 increased with 1,25(OH)₂D₃ dose ($P < 0.05$). In the absence of LPS, the effects of 1,25(OH)₂D₃ on iNOS and S100 A12 expression were minimal in comparison to the combined effects of LPS and 1,25(OH)₂D₃. RANTES gene expression in MEC did not increase with 1,25(OH)₂D₃ treatment as previously observed in activated monocytes, but did increase significantly with LPS treatment alone ($P < 0.05$). In conclusion, iNOS and S100 A12 expression induced by toll-like receptor signaling in mammary epithelial cells is up-regulated by 1,25(OH)₂D₃. Production of 1,25(OH)₂D₃ by 1 α -OHase in inflamed mammary tissue, then, may increase iNOS and S100 A12 expression in MEC during mastitis.

Key Words: vitamin D, immune response, mastitis

92 Effects of creep diet complexity on individual consumption characteristics and growth performance of neonatal and weaning pigs. R. C. Sulabo^{*}, M. D. Tokach, J. R. Bergstrom, J. M. DeRouchey, R. D. Goodband, S. S. Dritz, and J. L. Nelssen, *Kansas State University, Manhattan*.

In Exp. 1, 96 sows (PIC C29) and their litters were used to determine the effects of creep diet complexity on preweaning performance and proportion of piglets consuming creep feed. Treatments were: (1) no creep feed ($n = 26$); (2) simple creep diet ($n = 26$); and (3) complex

creep diet (n = 44). Creep feed was offered for 3 d prior to weaning. Pigs fed the complex creep diet had greater ($P < 0.03$) preweaning ADG and tended to have greater ($P < 0.06$) total gain than pigs fed the simple creep diet, with no creep pigs intermediate. Litters fed the complex creep diet consumed twice the total (1.24 vs. 0.62 kg; $P < 0.001$) and daily (412 vs. 205 g; $P < 0.001$) creep feed intake of litters fed the simple creep diet. The high-complexity creep diet improved ($P < 0.001$) the proportion of eaters from 28 to 68%. A greater ($P < 0.10$) proportion of eaters were nursing middle (57%) and posterior teats (52%) than anterior teats (38%). In Exp. 2, 675 pigs from Exp. 1 (initial BW 6.4 kg; 21.2 ± 0.2 d) were used to determine whether social facilitation occurs between eaters and non-eaters in commercial nursery groups. Treatments were: Non-eaters (pigs that were not provided any creep feed or non-eaters of creep feed), eaters (pigs that consumed creep feed), and a mixed group (51% non-eaters and 49% eaters). Each treatment had 9 replicate pens with 25 pigs per pen. In the initial 3 d postweaning, eaters had greater ($P < 0.01$) ADG and ADFI than non-eaters, with the mixed group intermediate. Overall (d 0 to 28), ADG of the eater group was higher (326 vs. 307 g; $P < 0.05$) than the non-eater group. In conclusion, the high-complexity creep diet improved preweaning ADG, creep feed intake, and the proportion of eaters. Eaters had improved postweaning feed intake, ADG, BW uniformity and reduced postweaning lag. Mixing eaters with non-eaters within pens in large commercial groups did not stimulate feed intake and daily gains of non-eaters, which indicates that social facilitation did not occur.

Key Words: creep feeding, complexity, pigs

93 Effects of wet corn gluten feed and wet distillers grains plus solubles on ruminal pH, feed intake and ruminal hydrogen sulfide during grain adaptation. J. O. Sarturi*, J. T. Vasconcelos, G. E. Erickson, T. J. Kloppenstein, K. M. Rolfe, V. R. Bremer, M. G. Dib, and C. D. Buckner, *University of Nebraska, Lincoln*.

A metabolism study was conducted to compare grain adaptation strategies including wet corn gluten feed (WCGF) and wet distiller grains plus solubles (WDGS). Six steers (BW = 300 ± 22 kg) were assigned randomly to 1 of 2 treatments in a completely randomized design (3 steers per treatment). Cattle were fed once daily for ad libitum intake. Both adaptation strategies started with 0% dry-rolled corn (DRC) and 87.5% byproduct (WCGF or WDGS). Five steps (7 d each) were used to increase DRC levels to 52.5% of dietary DM. All diets contained 7.5% alfalfa hay and 5% supplement. The last 7-d period consisted of a common finishing diet containing a blend of both WCGF and WDGS (17.5% of each), which was used as a covariate for the previous five steps for all variables. Intake and pH (wireless pH probes) measurements were collected daily. Ruminal gas samples were collected 8 h post feeding on the last 2 d of each period, and H_2S concentration was analyzed. Data were analyzed using the GLIMMIX procedures of SAS. The WCGF step-up strategy resulted in greater ($P > 0.05$) DMI than WDGS on steps 1, 2, and 3 (7.84 vs. 4.19; 9.58 vs. 6.85; 9.98 vs. 8.73 kg, respectively). Average pH was lower ($P > 0.05$) for WDGS on steps 2 and 3 (5.39 vs. 5.69; 5.57 vs. 5.85, respectively) compared to WCGF. No differences ($P < 0.05$) in H_2S concentrations between treatments were observed for steps 1, 2, 3, 4, and 5 (3.20 vs. 3.80; 0.65 vs. 0.51; 10.90 vs. 25.50; 2.40 vs. 4.60; 0.40 vs. 1.30 $\mu\text{mol/L}$ gas, for WCGF and WDGS, respectively). Likewise, no differences ($P < 0.05$) were observed for DMI, pH, and H_2S concentrations during the period in which cattle were fed the finishing diets. Both WCGF and

WDGS adaptation strategies resulted in safe ruminal pH, DMI and H_2S concentrations, even when S levels were high. Overall, both adaptation strategies effectively adapted cattle to finishing diets.

Key Words: adaptation, byproducts, intake

94 Metabolism characteristics of feedlot diets containing different by-product lipid sources. V. R. Bremer*, K. M. Rolfe, C. D. Buckner, G. E. Erickson, and T. J. Kloppenstein, *University of Nebraska, Lincoln*.

A completely randomized, 5-period Latin square design trial was conducted to evaluate the effects of dietary lipid source on the metabolism characteristics of feedlot steers fed 8.5% lipid diets. Treatments included 4 diets with different dietary lipid sources plus a CORN diet containing no added lipid. The OIL and TAL diets contained 4.8% of diet DM as corn oil or beef tallow, respectively. The CCDS diet contained added lipid in the form of condensed corn distillers solubles (CCDS; 25.5% of diet DM). The WDGS diet contained added lipid from corn wet distillers grains plus soluble (WDGS; 56% of diet DM). The four by-product diets were isolipid. Acetate as a proportion of ruminal VFA concentration was greatest for OIL and WDGS and least for CCDS. The acetate to propionate ratio was least for CCDS, although not significantly different ($P = 0.25$; 1.63, 1.62, 1.55, 1.26, and 1.16 for OIL, WDGS, CORN, TAL and CCDS, respectively). The CCDS diet had the lowest average ruminal pH ($P = 0.01$; 5.8, 5.6, 5.6, 5.4, and 5.3 for OIL, TAL, WDGS, CORN, and CCDS, respectively). The CCDS diet had greater DM digestibility than WDGS, OIL, or TAL ($P = 0.01$; 84, 76, 77, 80, and 81% for CCDS, WDGS, OIL, TAL, and CORN, respectively). CCDS had greater fatty acid digestibility than CORN and OIL ($P = 0.06$; 97, 94, and 94%, respectively). WDGS and TAL fatty acid digestibility was intermediate (95 and 95%, respectively). CCDS had greater NDF digestibility than OIL or TAL ($P = 0.01$; 69, 49, 60%, respectively). NDF digestibility was intermediate for WDGS and CORN (65 and 63%, respectively). Although CCDS lipid is similar to corn oil, CCDS had greater DM, fatty acid, and NDF digestibility than OIL. The omasal unsaturated fatty acid to saturated fatty acid ratio of steers fed WDGS was greater than when fed CCDS, CORN, TAL, or OIL ($P = 0.01$; 0.83, 0.52, 0.49, 0.40, 0.39 ratios, respectively). This indicates protection of WDGS fatty acids from ruminal biohydrogenation. Fatty acid absorption was not decreased with 8.5% lipid feedlot diets.

Key Words: byproducts, feedlot, lipid

95 Nutrient restriction from early to late pregnancy decreases circulating insulin like growth factor-1 concentrations in pregnant ewe lambs receiving maintenance or undernourishment. T. A. Wilmoth*¹, A. M. Meyer², M. E. Wilson¹, J. S. Caton², and K. A. Vonnahme², ¹West Virginia University, Morgantown, ²North Dakota State University, Fargo.

Ewes administered growth hormone around the time of conception have elevated concentrations of insulin-like growth factor-1 for the first 5 wk of pregnancy, and have heavier lambs at birth compared to vehicle treated ewes. Ewes that are nutrient restricted during mid to late pregnancy have lighter lambs at birth compared to adequately nourished ewes. It is our hypothesis that if nutrient restricted ewes have reduced insulin-like growth factor -1, administration of growth

hormone may negate lighter lambs at birth. Our specific objective was to determine the effects of nutritional restriction on insulin-like growth factor-1 concentrations throughout gestation. Rambouillet ewe lambs (52.1 ± 6.2 kg; 240 ± 17 d average age; $n = 42$) were randomly assigned to receive either 100% of NRC recommendations (CON) or 60% of CON (RES) on d 40 of gestation. Diets were fed to individually housed ewes once daily. Blood samples were collected every 14 d during gestation. Plasma was used for the determination of insulin like growth factor-1. IGF-I concentrations increased from d 39 to approximately d 110 and decreased beyond that for both the CON and RES groups. Between day 81 and day 95, IGF-I concentrations in maternal circulation diverged and remained higher in ewes fed at 100% of NRC compared to ewes fed at 60% of NRC for the duration of gestation. In fact, IGF-I concentrations were reduced by nearly 30% in ewes that consumed only 60% of NRC recommendations during the final two-thirds of gestation.

Key Words: pregnancy, IGF-1, undernourishment

96 Effects of crude glycerin on ruminal metabolism and diet digestibility in flaked corn finishing diets. G. L. Parsons* and J. S. Drouillard, *Kansas State University, Manhattan.*

The objectives of this study were to determine the effects of crude glycerin on apparent total tract digestibility, and to measure diurnal changes in ruminal pH and concentrations of ammonia and VFA. Crossbred steers ($n = 9$; 624 ± 80 kg) fitted with ruminal cannulae (Bar Diamond Inc., Parma, ID) were used in a replicated, complete block experiment with 3 treatments. Treatments consisted of steam-flaked corn diets containing 0, 2, and 4% crude glycerin (DM basis). Steers were allowed ad libitum access to finishing diets fed once daily. Diets contained 6% alfalfa hay, and provided 14% crude protein, 3.5% protein equivalent as non-protein nitrogen, 300 mg/d monensin, 90 mg/d tylosin, 2,200 IU/kg vitamin A, 0.3 % salt, 0.7% calcium, and 0.7% potassium. Periods consisted of a 10-d acclimation phase followed by a 3-d collection phase. Chromic oxide (10 g) was used as an indigestible marker to estimate total fecal output, and was dosed intraruminally prior to feeding beginning 7 d prior to the sampling phase. Dry matter intake was similar among treatments ($P > 0.98$). Fecal outputs were 1.21, 1.27, and 1.28 kg/d when glycerin was fed at 0, 2, and 4%, respectively ($P > 0.74$). Apparent total tract digestibilities of DM, OM, starch, CP, and crude fat were similar for cattle fed the different dietary treatments ($P > 0.51$). Apparent total tract digestibilities of NDF were 60.4, 51.8, and 48.1 for cattle fed 0, 2, and 4% glycerin, respectively (Lin, $P < 0.01$). No treatment by time interactions were observed for ruminal parameters ($P > 0.27$). Feeding glycerin linearly increased mean ruminal pH from 5.61 in control steers to 5.67 and 5.73 when glycerin was added at 2 and 4 %, respectively ($P < 0.053$).

Concentrations of butyrate and valerate decreased as crude glycerin increased in the diet (Lin, $P < 0.03$). Acetate concentrations decreased with increasing glycerin concentrations (Lin, $P = 0.06$). When fed at low levels in finishing diets, glycerin appears to alter digestion of fiber, but has little impact on other components of the diet.

Key Words: glycerin, digestibility, steam-flaked corn

97 Effects of spaying and terminal implant strategy on performance and carcass characteristics of beef feedlot heifers. J. M. Kelzer*¹, C. R. Dahlen², G. I. Crawford³, and A. DiCostanzo¹, ¹*University of Minnesota, St. Paul,* ²*University of Minnesota Northwest Research and Outreach Center, Crookston,* ³*University of Minnesota Extension Regional Office, Hutchinson.*

Crossbred beef heifers ($n = 139$) averaging 273 ± 22 kg initial BW were blocked by weight (heavy; HY, and light; LT) and assigned to 1 of 16 pens. Pen was assigned randomly to treatments within block to evaluate effects of reproductive status (spayed vs. intact) and terminal implant strategy (moderate; 200 mg testosterone propionate + 20 mg estradiol benzoate vs. aggressive; 200 mg trenbolone acetate + 28 mg estradiol benzoate) on performance and carcass characteristics. On d -14, 8 pens of heifers ($n = 70$) were spayed via the ovarian-drop technique. On d 1, all heifers were implanted (100 mg progesterone + 10 mg estradiol benzoate) and were fed backgrounding diets (1.10 Mcal NEg/kg DM, 14.2% CP) at 2.0% BW for 65 or 85 d (HY and LT blocks, respectively). On d 66 and 86 respectively, HY and LT heifers received terminal implants to begin the finishing phase. Heifers were fed diets (1.32 Mcal NEg/kg DM, 11.4% CP, 360 mg/d monensin, 90 mg/d tylosin) ad libitum. Intact heifers received melengesterol acetate (0.5 mg/d) for estrus suppression. On d 146 and 174 respectively, HY and LT heifers were harvested at a commercial abattoir. During backgrounding, intact heifers had greater DMI ($P = 0.02$; 6.56 vs. 6.43 ± 0.06 kg/d), greater ADG ($P = 0.02$; 1.60 vs. 1.46 ± 0.05 kg), improved G:F ($P = 0.05$; 0.244 vs. 0.228 ± 0.006), and heavier final BW ($P = 0.04$; 391 vs. 382 ± 4 kg). During finishing, no status x implant interactions occurred ($P > 0.88$) for performance. Moderate implant increased DMI ($P = 0.05$; 8.91 vs. 8.54 ± 0.21 kg/d) over aggressive, but ADG was similar among all heifers. Intact heifers and aggressive implant tended ($P = 0.06$) to have improved G:F. Final BW, HCW, LM area, marbling score, and 12th rib fat thickness were not influenced by spaying or implanting. Intact heifers receiving melengesterol acetate had greater performance than spayed heifers during backgrounding; however, aggressive implanting may allow similar performance during finishing.

Key Words: spayed heifers, implants, feedlot performance

Graduate Student Poster Competition-M.S.

98 Water nipple placement, posture and directionality of gestating sows in turnaround stalls. A. R. Hanson*, P. M. Walker, and J. P. Holt, *Illinois State University, Normal.*

Criticism of straight gestation stalls necessitates the development of options such as loose housing and turnaround stalls. Design details such as water nipple placement may affect a sow's propensity for movement. A preliminary trial observing dry sows in turnaround stalls was conducted comparing stall location within the barn and water nipple placement on the posture and directionality of sows, involving 3 treatments. Treatment T consisted of 6 sows in turnaround stalls adjacent to other sows on all 4 sides with a water nipple placed in the rear of the stall opposite the feeding area. Treatments M (n = 5) and W (n = 4) had the water nipple located in the front of the stall next to the feeding area. Treatment W was surrounded by sows on 3 sides, with a wall along the rear. Treatment M had sows on all 4 sides. For each treatment, recorded video for 5d was analyzed for sow time spent lying, standing, sitting, and facing front, rear, or lateral along with number of times each sow changed direction (from front to rear or rear to front) for each of 3 periods/observation day (0830-0930, 1200-1300, and 1500-1600). Data were combined across periods and observation days, and converted to percent/sow for analysis by a one way ANOVA in SAS with a Tukey test to compare treatment means ($P < 0.05$). Time spent standing was the highest in T stalls ($80.3 \pm 7.45\%$ compared to $53.6 \pm 8.18\%$ and $58.5 \pm 17.97\%$ for W and M stalls, respectively). Sows kept in W stalls spent more time facing the front than M sows ($76.3 \pm 24.22\%$ v. $32.7 \pm 4.59\%$), indicating that they did not turnaround to face the wall. The number of times turning did not significantly differ between treatments, but with 17.2 ± 16.6 turns, sows kept in the W stalls turned less than those in M and T stalls, compared to 33 ± 17.1 and 33.6 ± 11.9 turns, respectively. This trial indicates that location of water nipple does not impact sow directionality, but placement of the sow within the barn affects direction and posture of sows. Further research with larger numbers of sows should be conducted.

Key Words: turnaround stall, sow housing, water nipple

99 Comparison of finishing diets for steers containing 25%, 40%, or 70% wet distillers grains. J. M. Carmack*, P. M. Walker¹, and L. A. Forster², ¹*Illinois State University, Department of Agriculture, Normal*, ²*Archer Daniels Midland Co, Decatur, IL.*

Few studies have been conducted evaluating inclusion rates of modified wet corn distillers grains with solubles (DGS) above 45% of the diet DM for finishing beef steers. The objective of this trial was to evaluate feedlot performance and carcass characteristics of growing/finishing beef steers fed with various levels of DGS. The treatments (percent DM basis) were: 25 DGS/60 shelled corn/15 corn silage (25 DGS), 40 DGS/45 shelled corn/15 corn silage (40 DGS), 70 DGS/15 shelled corn/15 corn silage fed 84 d then switched to 40 DGS for 149 d (70/40) and 70 DGS/15 shelled corn/15 corn silage (70 DGS). Angus cross steers (n = 130; 356 ± 42 kg BW) were blocked by source (2 blocks) and stratified by weight to 20 pens (10 pens/block) with unequal pen replication. Seventy head (all steers in block one) were harvested on d 149 when 90% were estimated to have reached low choice or higher quality grade. Steers from block two were harvested on d 216 when 90% were estimated to have reached low choice or higher quality grade. No block x treatments x harvest date interactions were observed. Steers fed 70 DGS had higher ($P < 0.05$) ADFI during the entire feeding trial than steers fed 25 DGS

steers. During the first 84 d on feed 70/40 and 70 fed steers had higher ($P < 0.01$) ADFI. From d 85 to d 216 only 70 fed steers had higher ADFI ($P < 0.01$). No significant differences between treatments were observed for DMI, ADG or G:F for the first 84 d. From d 85 to d 216, 25 fed steers had lower ($P = 0.01$) DMI and 70/40 fed steers tended ($P = 0.25$) to have higher ADG. No significant differences between treatments were observed in carcass wt, ribeye area, rib fat thickness, KPH % and liver score. While no significant differences were observed for yield grade and quality grade (mean = average choice), 70 DGS steers tended to have slightly higher yield grade ($P = 0.17$). Results from this single feeding trial suggest that steers fed various levels of DGS have similar feedlot performance and similar carcass characteristics.

Key Words: distillers grains, diet, inclusion rates

100 Production of value-added pork by enrichment with omega-3 fatty acids. C. Brown*¹, X. Lin¹, E. van Heugten¹, R. Harrell², D. Hanson¹, and J. Odle¹, ¹*North Carolina State University, Raleigh*, ²*Novus International, St. Charles, MO.*

This study evaluated the impact of dietary docosahexaenoic acid (DHA) and linolenic acid (LN) on enrichment of n - 3 fatty acids in pork when supplemented for the last 4 or 8 wk of the finisher period. Diets consisted of a corn-soybean meal based control supplemented with 0, 1.5 or 3.0% DHA-GOLD (Martek Biosciences Corp, Columbia, MD) to supply 0, 0.27, or 0.54% DHA, respectively, or with 1.04% flax seed oil (Jedwards International, Quincy, MA) to supply 0.54% LN. Products were substituted for a saturated fat source (Fat Pack 100, Milk Specialties, Dundee, IL). Pigs (n = 40, 67.7 ± 1.1 kg BW) were housed individually and given ad libitum access to feed and water. Pigs were slaughtered at 115.6 ± 5.4 kg BW and a 2.5 cm thick loin chop was collected from each pig. Chops were trimmed into retail cuts and subsequently ground to obtain a homogeneous sample. Fat was extracted and fatty acid concentrations were determined using gas-liquid chromatography. Fat supplements did not affect ($P > 0.05$) daily weight gain (0.90 ± 0.15 kg), feed intake (2.77 ± 0.65 kg) or gain:feed (0.36 ± 0.06), but increased DHA accumulation linearly with diet concentration and with feeding duration ($P < 0.05$). Supplemental LN tended to increase ($P = 0.08$) loin LN at wk 8 only. We conclude that pork loin content of n-3 fatty acids can be markedly enriched in as little as four weeks of supplementation during the late finisher phase. Furthermore, DHA was enriched more efficiently than LN, and LN supplementation did not alter DHA, suggesting low elongation and/or desaturation.

Table 1. Omega-3 fatty acid enrichment of loin chops from pigs fed DHA or LN

Dura- tion	Four Weeks				Eight Weeks				SEM
	Control	DHA	DHA	LN	Control	DHA	DHA	LN	
Diet	0%	0.27%	0.54%	0.54%	0%	0.27%	0.54%	0.54%	
LN, wt%	0.60	0.36	0.42	0.76	0.47	0.40	0.61	0.80	0.13
DHA, wt%	0	0.32	0.93	0.01	0	0.61	1.45	0	0.13

Key Words: docosahexaenoic acid, linolenic acid, pork quality

101 The evaluation of the additive effect of zinc and copper supplementation from organic and inorganic sources on growth performance of nursery pigs. M. R. Marchant*, P. M. Cline, T. C. Tsai, M. J. Azain, and C. R. Dove, *University of Georgia, Athens*.

Three hundred crossbred pigs (150 gilts and 150 barrows, 3 trials of 100 pigs) were weaned at 21 ± 2 (initial Wt. 6.27 kg) and housed 5 per pen. Pigs were blocked by weight and gender, resulting in 6 replicates per treatment. Pigs within a pen were assigned in a RCB design to one of 10 dietary treatments. Treatments were arranged in a 2×4 factorial with 15 or 250 ppm Cu as CuSO_4 and 25, 50, 75, or 100 ppm Zn as organic Zn (Bioplex Zn, Altech Inc.). Positive control diets containing either 15 or 250 ppm Cu and 100 ppm ZnO were included in the study. All diets met or exceeded NRC requirements. Diet phases were changed and pigs were weighed, feed intake recorded and a blood sample collected on d 0, 7, 21, and 35 of the 35 d. Pigs were housed in an environmentally controlled building with ad libitum access to feed and water. Over the 35 d trial, there were no Cu \times Zn interactions ($P > 0.1$) detected. The addition of 250 ppm Cu increased ADG (291 vs 342 g/d for 15 and 250 ppm Cu respectively), ADFI and G:F ($P < 0.01$) over the 35 d trial compared to the 15 ppm Cu diet. ADG increased cubically ($P < 0.05$) with organic Zn addition (312, 310, 334, 292 g/d for 25, 50, 75, and 100 ppm, respectively) with 75 ppm organic Zn resulting in the highest ADG. ADG of pigs fed 75 ppm organic Zn was similar to ADG of pigs fed 100 ppm ZnO (334 vs 336 g/d). Organic Zn addition tended ($P < 0.08$) to increase ADFI (522, 526, 541, 492, g/d for 25, 50, 75 and 100 ppm organic Zn respectively) in a manner similar to the increase in ADG. Feed intake of pigs fed 75 ppm organic Zn was similar (541 vs 543) to intake of pigs fed 100 ppm ZnO. Organic Zn had no effect on G:F ($P > 0.10$). The addition of Cu or Zn had no effect ($P > 0.10$) on serum Cu, Fe or Zn. Data from this study indicate that pigs fed 75 ppm organic Zn have performance similar to those fed 100 ppm ZnO and that the addition of 100 ppm organic Zn decreased performance compared to those pigs fed 100 ppm ZnO.

Key Words: copper, zinc, nursery pigs

102 Interaction of *Bacillus* spp. and *Salmonella enterica* serovar Typhimurium in immune/inflammatory signaling from swine intestinal epithelial cells. C. Aperce*¹, T. E. Burkey², B. KuKanich³, B. A. Crozier-Dobson¹, S. S. Dritz⁴, and J. E. Minton¹, ¹*Kansas State University, Animal Sciences and Industry, Manhattan*, ²*University of Nebraska, Animal Sciences, Lincoln*, ³*Kansas State University, Anatomy and Physiology, Manhattan*, ⁴*Kansas State University, Diagnostic Medicine/Pathobiology, Manhattan*.

Previous research evaluated a laboratory strain of *Bacillus licheniformis* (BL) in a swine gut epithelium model system and found it exerted anti-inflammatory effects on *Salmonella enterica* serovar Typhimurium (S)-induced secretion of interleukin-8 (IL-8). This study evaluated the anti-inflammatory actions of *Bacillus* bacteria available commercially as feed additives for the swine industry. Three isolates were obtained from the product, two *Bacillus subtilis* (BS1 and BS3) and one *Bacillus licheniformis* (BL2). Swine jejunal epithelial IPEC-J2 cells were seeded into wells on permeable membrane supports and allowed to form confluent monolayers. The ten treatments included negative control wells receiving no bacteria (C), positive control wells receiving only 10^8 CFU of S in the final 1h incubation, and wells receiving apical pretreatment (17h) with BL, BS1, BL2, or BS3 in presence or absence of S. After incubation, wells were washed and media containing gentamicin was added. Cells were incubated for 5 h, after which apical and basolateral

media were recovered for quantitation of IL-8. Inserts that had received S were lysed and lysates cultured to determine treatment effects on S invasion. Exposure to S alone provoked an increase in IL-8 secretion from IPEC-J2 cells, in both apical and basolateral directions, compared to C wells ($P < 0.001$). Pre-treatment with each *Bacillus* isolate reduced the S-induced IL-8 secretion in both directions compared to the wells receiving only S ($P < 0.01$). Fewer S colonies were cultured from lysates of BL2 + S compare to other treatments ($P < 0.001$). Results suggest that *Bacillus subtilis* and *Bacillus licheniformis* have the ability to intervene in the S-induced secretion of IL-8 from swine intestinal epithelial cells. This effect on chemokine secretion by gastrointestinal epithelial cells *in vitro* could not be explained solely by reduced invasion of epithelial cells by *Salmonella enterica* serovar Typhimurium.

Key Words: *Bacillus*, *Salmonella*, swine

103 Acid marination for tenderness enhancement of the beef round. J. Hinkle*, C. Calkins, A. de Mello Jr., L. Senaratne, and S. Pokharel, *University of Nebraska, Lincoln*.

The objective of this study was to document the tenderness and color effects of marinating m. *biceps femora* ($n = 72$ bottom rounds). Acid solutions (lactic acid, acetic acid and sodium citrate dehydrate) at 4 concentrations (0.1 M, 0.5 M, 0.75 M and 1.5 M) were prepared for 2 experiments. In experiment 1 and 2, *Biceps femora* muscles were pumped to 7% and 10% of their initial weight, respectively. Experiment 1 treatment levels were 0.1 M and 0.5 M concentrations; whereas, the treatment levels for experiment 2 were 0.75 M and 1.5 M concentrations. Objective color measurements were taken at 0, 1, and 8 h after marinating for experiments 1 and 2. Cooking loss and tenderness were analyzed, after injection, for experiment 1 and 2. In experiment 1, steaks were cut at 0, 1, and 8 h and on days 1, 3, 5, 7, 14, 21 and 28. In experiment 2, samples were collected the same as in experiment 1, except there were no 21 and 28 day samples. Color was measured after bloom at 0, 1 and 8 h post-injection for both experiments. No effect of tenderness ($P = 0.11$) was observed from experiment 1. Experiment 2 has shown a significant ($P = 0.04$) decrease in tenderness from 1 hour to 1 day at the higher concentrations of acid; while, a significant ($P = 0.02$) increase in tenderness was observed from 1 to 14 days. All muscles marinated with 0.1 M sodium citrate, acetic and lactic acid increased significantly in lightness at 8 h ($P < 0.05$). Both redness (a*) and yellowness (b*) decreased for all six treatments from 0 to 8 h ($P < 0.05$) for experiment 1. For experiment 1, a significant time \times treatment interaction was observed for lightness ($P = 0.04$); although, experiment 2, had not shown a significant interaction in lightness ($P = 0.62$). At the injection site, acetic and lactic acids altered the color of meat from red to a dark gray. Results of this work demonstrated that acid marinating at low concentration has no effects on tenderness at low concentrations; but, shows significant ($P = 0.02$) increase in tenderness at higher concentrations.

Key Words: beef, acid marination, biceps femoris

104 Effects of crystalline lactose on expression of sodium-dependent glucose transporter-1 mRNA and glucose transport in porcine jejunal epithelial cells. H. Tran*, P. S. Miller, and T. E. Burkey, *University of Nebraska, Lincoln*.

An experiment was conducted to evaluate the effects of crystalline lactose on the expression of sodium-dependent glucose transporter

(SGLT)-1 mRNA and glucose transport in vitro, in model porcine jejunal epithelial (IPEC-J2) cells. The IPEC-J2 cells are non-transformed, jejunal epithelial cells originally derived from a neonatal pig and are maintained as a continuous culture. The IPEC-J2 cells were seeded into a permeable transwell culture system and grown to confluency prior to exposure to the following apical (representative of the gut lumen) treatments: 1) Control; 2) Lipopolysaccharide (LPS; 10 ng/mL); 3) Low lactose (28 mM); 4) High lactose (56 mM); 5) Low lactose + LPS; or 6) High lactose + LPS. Total RNA, and media samples (from both apical and basolateral compartments) were harvested at 3, 6, 12, and 24 h following the addition of respective treatments. With respect to expression of SGLT-1, there were no interactions of lactose, LPS, and time; however, a main effect of lactose ($P < 0.01$) was observed. Cells treated with a high concentration of lactose had greater relative abundance of SGLT-1 mRNA compared to the control ($P = 0.003$) and low lactose ($P = 0.02$) treated cells. As expected, glucose transport was polarized towards the basolateral, rather than the apical compartment ($P = 0.04$) in a time-dependent manner ($P < 0.001$). The addition of LPS had no effect on expression of SGLT-1 mRNA; however, LPS tended ($P < 0.07$) to decrease basolateral glucose transport compared to control- and lactose-treated cells. Interestingly, supplementation of lactose in LPS-treated cells tended to reduce the LPS-mediated inhibitory effect on glucose transport from the apical to basolateral compartment ($P = 0.07$). Lactose, the products of lactose digestion (glucose, galactose), or a combination of both affect SGLT-1 gene expression in IPEC-J2 cells.

Key Words: glucose transport, lactose, SGLT-1

105 Effects of process pH and temperature on stability of wheat gluten films against ruminal fermentation. K. Blaine* and J. S. Drouillard, *Kansas State University, Manhattan.*

Two experiments were conducted to identify initial processing conditions for production of wheat gluten films that are resistant to degradation by ruminal microorganisms, with the goal of developing films for encapsulation of micronutrients. Experiment 1 evaluated effects of film solution pH (3, 4, 5, 6, 7.5, 9 or 11) on susceptibility of films to microbial degradation. Films were prepared by combining wheat gluten (27 g) in 150 mL of a 2:1 ethanol:water solution. Glycerol was added at 1% as a plasticizing agent. Glacial acetic acid and 6N ammonium hydroxide were used to achieve target pH of film solutions. Experiment 2 was a randomized complete block design with a $3 \times 3 \times 5$ factorial treatment arrangement. Factors were pH (3, 5, and 7.5), process temperature (40, 55 and 75°C), and fermentation time (0, 2, 4, 6 and 8 h). Solutions were heated on a hotplate and refluxed for 10 min at the target temperature. For both experiments, film-forming solutions were cast onto Teflon trays and dried at ambient temperature. Dried films were subjected to an in vitro assay to estimate release of ammonia and total amino acids. Experiment 1 revealed an effect of pH on film stability (lin. and quad., $P < 0.001$); pH 3 yielded films with the greatest resistance to degradation. In Experiment 2, there was a pH \times temperature interaction ($P < 0.01$). Films manufactured at 75°C and low pH 3 were most resistant to microbial degradation, whereas those manufactured at pH 5 and at lower temperatures (40 and 55°C) were extensively degraded. There was a quadratic effect of film solution pH ($P < 0.001$), with pH 5 yielding the greatest susceptibility to degradation. Film degradability was decreased with increasing temperature (linear, $P < 0.01$). Films manufactured at pH 3 and 75°C were 37% degraded after 8 h fermentation time. Low pH and high temperature of film forming solutions show the greatest potential for producing gluten-based films that are resistant to micro-

bial fermentation in the rumen, thus offering an economical means for encapsulating micronutrients.

Key Words: encapsulation, pH, wheat gluten

106 Effects of re-ensiling corn silage or haycrop silage with wet distillers grains with solubles on aerobic stability of feed mixtures. N. S. Schmelz*, M. M. Schutz, T. D. Nennich, R. P. Lemenager, D. Buckmaster, and S. S. Donkin, *Purdue University, West Lafayette, IN.*

Long-term storage of wet distillers grains with solubles (WDGS) is problematic for small to medium sized dairy production units due to its high bulk density and lack of aerobic stability (AS). The objective of this study was to determine the effects of combining WDGS with previously ensiled forages as method to reduce the bulk density of WDGS. Mixtures of corn silage (CS) or haycrop silage (HS) and WDGS were evaluated for post-ensiling AS, pH, and volatile fatty acid (VFA) profile. Either CS or HS were blended with WDGS to create mixtures, on a DM basis, of 25:75, 50:50, 75:25, and 100:0. Six replicates per mixture were packed in 25 kg mini silo bags, vacuum-sealed, and stored for 30 or 90 d. Aerobic stability, defined as the time required to achieve an increase of 2°C with removal from the mini silos, was 24.3 ± 3.8 and 60.2 ± 19.7 for HS and CS, respectively. Storage of WDGS with HS for 30 d, linearly increased ($P < 0.05$) the AS of the forage but mixing with CS increased the stability in a quadratic manner ($P < 0.05$). For both CS and HS, increased amounts of WDGS resulted in decreased acetic acid. Combining 25% HS with 75% WDGS and re-ensiling the mixture does not impact AS (24.3 vs. 66.6 ± 3.8 ; $P > 0.05$). Combining CS with 25% WDGS and storing for 30 d does not impact AS (60.3 vs. 70.6 ± 19.7 ; $P > 0.05$) but additional combinations of 50 or 75% DGS reduced ($P < 0.05$) AS of the re-ensiled material (44.3 , 41.7 ± 19.7 h for 50 and 75% WDGS respectively). Aerobic stability of all mixtures of WDGS and forages were in excess of 122 h when re-ensiled for 90 days prior to unsealing. Using WDGS and previously stored CS or HS provides storage options that increase the bulk density of WDGS and provides an aerobically stable forage WDGS mixture.

Key Words: aerobic stability, mini silos, WDGS

107 Effect of feeding diets containing corn dried distillers grains with soluble (DDGS) and beef tallow to growing-finishing pigs on fresh and processed pork shelf life characteristics. J. Popowski*, R. Cox, J. Pomeroy, G. Shurson, and R. LaBerge, *University of Minnesota, Twin Cities.*

The objective of this study was to determine the effects of feeding corn dried distillers grains with and without supplemental beef tallow to growing-finishing swine on shelf-life of fresh ground pork and fresh pork sausage. Dietary treatments consisted of a conventional corn-soybean diet (CON), CON containing 30% DDGS (DDG), CON containing 5% beef tallow (TAL) and CON with 30% DDGS and 5% tallow (TDG). Fresh pork picnic shoulders were removed 24h postmortem and bone was removed to produce uniform lean trim. Pork trim was ground twice (0.375 cm) and each ground pork block per animal was divided into two (0.91kg) batches; one for fresh evaluation (FRESH) and one for fresh sausage production and evaluation (SAUSAGE). FRESH and SAUSAGE samples were spread evenly in a retail polystyrene tray, covered with PVC film and stored at 4°C under cool white fluorescent lighting. Surface L^* , a^* and b^* colorimetric values were taken using a

Hunter MiniScan XE Plus Spectrophotometer every 24 h for 14 d starting at day 0. Each tray measurement was taken in triplicate to ensure uniformity of sampling. Results indicate that inclusion of beef tallow in diets containing DDGS may improve shelf life color characteristics, however, further research is required.

Table 1. Colorimetric L*, a* and b* values for fresh ground pork and pork sausage in retail shelf conditions from swine fed conventional CON, DDG, TAL, and TDG during the growing-finishing period.

	FRESH			SAUSAGE		
	L*	a*	b*	L*	a*	b*
CON	49.70 ^a	1.44 ^a	12.18 ^a	46.62	2.69 ^a	13.05 ^a
DDG	47.96	1.51 ^a	14.17 ^a	42.62	3.26 ^a	13.37 ^a
TAL	49.65 ^a	2.04 ^a	12.12 ^a	45.65	3.36 ^a	13.52
TDG	48.22 ^a	1.70 ^b	11.66 ^a	43.60	3.66 ^a	12.38 ^a

^{a-c}Means within a column lacking a common superscript letter differ significantly ($p < 0.05$).

Key Words: dried distillers with solubles, tallow, pork quality

108 Effect of supplemental molybdenum on forage-fed steers receiving high-sulfur water. K. L. Kessler^{*1}, K. C. Olson², C. L. Wright², K. J. Austin¹, P. S. Johnson², and K. M. Cammack¹, ¹University of Wyoming, Laramie, ²South Dakota State University, Brookings.

Poor performance and S-induced polioencephalomalacia (sPEM) have been observed in regions with high-S livestock drinking water.

Identification of a feed supplement that ameliorates the effects of high-S water would benefit ruminant livestock producers in those regions. The objective of this study was to determine if supplementing Mo, a metallic trace element known to interact with S, improves health and performance of forage-fed steers administered high-S drinking water. Yearling steers ($n = 96$) were randomly assigned to 1 of 3 treatment groups for a 56 d trial: low-S water (LS; 375 mg $\text{SO}_4\text{-L}^{-1}$), high-S water (HS; 2,218 mg $\text{SO}_4\text{-L}^{-1}$), or high-S water plus Mo (HSMO; 2,218 mg $\text{SO}_4\text{-L}^{-1}$; 100 mg $\text{Mo}\cdot\text{kg}^{-1}$ DM). All treatments were supplemented with 10 mg $\text{Cu}\cdot\text{kg}^{-1}$ DM. Body weight and ruminal H_2S gas concentration were collected on d -1, 29, and 57. Animals were monitored ≥ 3 times daily for general health and signs of sPEM. One case of sPEM was confirmed in the HS treatment group. Feed intake was lower in HSMO steers than HS ($P = 0.018$) and LS ($P = 0.002$) steers. No intake differences were observed between LS and HS steers. Average daily gain was lower ($P < 0.001$) in HSMO steers than LS and HS steers, with HS steers being intermediate to the other two treatments. No differences ($P > 0.05$) in water intake were observed. There was no effect of treatment on initial or mid-trial ruminal H_2S gas concentrations. Final day ruminal H_2S gas concentration was greater in HSMO steers compared to LS ($P = 0.006$) and HS ($P = 0.013$) steers; no differences were observed between LS and HS steers. These results indicate that a Mo supplement is not beneficial in counteracting the effects of high-S water consumption, and may exacerbate the effects associated with high dietary S.

Key Words: sulfur, molybdenum, polioencephalomalacia

Graduate Student Poster Competition-Ph.D.

109 Effects of feeder design, gender, and dietary concentration of dried distillers grains with solubles on the growth and carcass characteristics of finishing pigs. J. R. Bergstrom^{*}, M. D. Tokach, S. S. Dritz, J. L. Nelssen, J. M. DeRouchey, and R. D. Goodband, *Kansas State University, Manhattan.*

A total of 1,080 pigs (PIC 337 \times 1050; 35.1 kg) were used in a 99-d experiment to evaluate the effect of conventional dry (CD) and wet-dry (WD) feeder designs, gender (barrow or gilt), and dried distillers grains with solubles (DDGS) level (20 or 60%) on finishing pig performance. There were 5 pens per treatment for the 8 treatments, and 20 pens for the main effects. Pigs were sorted by gender into groups of 27, weighed, and allotted to pens. Diets were fed in 3 phases to d 78. On d 78, 2 pigs/pen were weighed and removed for harvest. Remaining pigs were fed a common diet containing 20% DDGS and 5 ppm Paylean until carcass data were obtained on d 99. Jowl fat samples were collected from 2 pigs/pen on d 78 and 99 for fatty acid and iodine value (IV) analysis. Overall, pigs using WD had greater ($P < 0.001$) ADG (936 vs. 870 g/d), ADFI (2595 vs. 2292 g/d), final BW (128.2 vs. 121.8 kg), feed cost/pig (fd\$pig, \$94.12 vs. 82.04), HCW (95.0 vs. 90.4 kg), and backfat depth (BF, 18.8 vs. 16.3 mm), but decreased ($P < 0.05$) G/F (0.36 vs. 0.38), fat-free lean (FFL, 49.8 vs. 50.6%), jowl IV (75.7 vs. 77.9), and margin-over-feed-cost (MOF, \$21.70 vs. 31.71). Feeding 60% DDGS from d 0 to 78 resulted in decreased ($P < 0.02$) ADG (894 vs. 912 g/d), G/F (0.37 vs. 0.38), final BW (124.1 vs. 125.9 kg), fd\$pig (\$84.14 vs. 92.02), HCW (91.7 vs. 93.7 kg), and BF (17.1 vs. 18.0 mm), but increased ($P < 0.05$) FFL (50.4 vs. 50.1%), jowl IV (81.7 vs. 72.0), and

MOF (\$29.81 vs. 23.60). Barrows had greater ($P < 0.01$) ADG (914 vs. 893 g/d), ADFI (2533 vs. 2354 g/d), final BW (126.5 vs. 123.5 kg), fd\$pig (\$91.83 vs. 84.33), HCW (94.1 vs. 91.3 kg), and BF (19.3 vs. 15.8 mm); but reduced ($P < 0.01$) G/F (0.36 vs. 0.38), FFL (49.5 vs. 50.9%), jowl IV (75.5 vs. 78.2), and MOF (\$22.88 vs. 30.52). In conclusion, the greatest MOF resulted from feeding gilts 60% DDGS using a CD feeder. More research with WD feeders is needed to resolve concerns with G/F, carcass leanness, and economic returns.

Key Words: DDGS, feeders, pigs

110 Mannan oligosaccharides (MOS) modulate gene expression profile in pigs experimentally infected with porcine reproductive and respiratory syndrome virus (PRRSV). T. M. Che^{*1}, R. W. Johnson¹, K. W. Kelley¹, W. G. Van Alstine², K. A. Dawson³, and C. A. Moran³, ¹University of Illinois, Department of Animal Sciences, Urbana, ²Purdue University, Animal Disease and Diagnostic Laboratory, West Lafayette, IN, ³Alltech North American Bioscience Center, Nicholasville, KY.

This study characterized gene expression in peripheral blood mononuclear cells (PBMC) and bronchoalveolar lavage fluid (BALF) cells from control-or MOS (Bio-Mos)-fed pigs with or without PRRSV at d 7 postinfection (PI). Weaned pigs (3 wk old) fed 0% or 0.2% MOS diets were intranasally inoculated with PRRSV or medium at 5 wk old. Total RNA (3 pigs/treatment) was extracted from cells. Double-stranded cDNA was amplified, labeled, and further hybridized to the Affyme-

trix GeneChip Porcine Genome Array consisting of 23,937 probe sets representing 20,201 genes. Microarray data were analyzed in R using packages from the Bioconductor project. Differential gene expression was tested by fitting a mixed linear model equivalent to a 2 x 2 factorial ANOVA using the *limma* package. Dietary MOS and PRRSV changed the expression of thousands of probe sets in PBMC and BALF cells ($P < 0.05$). The MOS x PRRSV interaction altered the expression of more non-immune probe sets in PBMC (977 up and 1128 down) than in BALF cells (117 up and 78 down). The MOS x PRRSV interaction ($P < 0.05$) for immune probe sets in PBMC affected genes encoding key inflammatory mediators. In uninfected pigs, gene expression of IL-1 α , IL-6, myeloid differentiation factor 88, toll-like receptor (TLR) 4, and dead box polypeptide 58 increased in PBMC of MOS-fed pigs ($P < 0.05$). This suggests that MOS enhances disease resistance in pigs and supports the fact that MOS induced rapid increase in leukocytes at d 3 and 7 PI. Within infected pigs, MOS, however, reduced the expression of IL-1 β , IL-6, IL-8, macrophage inflammatory protein (MIP)-1 α , MIP-1 β , monocyte chemotactic protein (MCP)-1, and TLR4 genes in PBMC ($P < 0.05$). This finding may explain why fever was ameliorated in infected pigs fed MOS by d 7 PI. The expression of IL-1 β , IL-6, MIP-1 β , MCP-1, and TLR4 genes analyzed by real time RT-PCR confirmed the microarray results. In short, MOS modulated the expression of non-immune and immune genes in leukocytes of PRRSV-infected pigs, perhaps providing benefits by enhancing immunity while preventing over-stimulation of the immune system.

Key Words: gene expression, MOS, pigs

111 Mapping of intramuscular tenderness and muscle fiber orientation of major muscles in the beef round. L. Senaratne*, C. Calkins, A. de Mello Jr., S. Pokharel, and J. Hinkle, *University of Nebraska, Lincoln*.

The intramuscular tenderness variation and muscle fiber orientation of beef *m. adductor femoris* (AF), *m. biceps femoris* (BF), *m. semimembranosus* (SM), and *m. semitendinosus* (ST) were investigated. The AF, BF, ST, and SM ($n = 10$ each) were cut into 2.54 cm thick steaks perpendicular to the long axis and grilled (71°C). Location specific cores were prepared from each section and Warner-Bratzler shear force (WBSF) was measured. The overall mean WBSF values for BF, ST, AF, and SM were 5.62, 4.86, 4.18, and 4.90 kg, respectively. The mean WBSF for the long and ischiatic heads of BF were 5.62 kg and 7.46 kg, respectively. The muscle fiber orientations of BF was bipennate, ST was fusiform, and AD and SM was unipennate. However, the sirloin/round separation region of BF had more horizontal fiber orientation than the rest of the muscle. The degrees of inclination of muscle fibers of the long head of BF were gradually more angular from the proximal to the distal end. There was no variation of muscle fiber orientation in the ischiatic head of BF from the proximal to the distal end (muscle fibers were parallel to the long axis of the muscle). Based on WBSF values, BF was tough, and SM, AF and ST were intermediate. The WBSF values of first 2 to 3 steaks of BF, SM and AF were tender compared to the rest of the muscles and they could be marketed as premium quality round steaks. Dry or moist heat roasting of ST muscles significantly improved tenderness compared to grilling of steaks ($P < 0.05$). This information on intramuscular tenderness variation and muscle fiber orientation of major muscles in the round could be used in a value added strategy for the round.

Key Words: beef round muscles, intramuscular tenderness, muscle fiber orientation

112 Feeding modified distillers grains plus solubles to cattle affects the fatty acid profile of beef. A. de Mello Jr.*, B. Jenschke, L. Senaratne, T. Carr, G. Erickson, and C. Calkins, *University of Nebraska, Lincoln*.

Wet distillers grains contain approximately 65% moisture. A partially dried product (Modified Distillers Grains plus Solubles; MDGS) contains about 50% moisture. The objective of this study was to investigate the effects of MDGS finishing diets on marbling attributes, proximate composition, and fatty acid profile of beef. Yearling steers ($n = 268$) were randomly allotted to 6 treatments based on MDGS (0, 10, 20, 30, 40 and 50% – DM basis) and fed for 176 d prior harvest. Forty-eight h postmortem, marbling score, marbling texture and marbling distribution were assessed by a USDA grader and one ribeye slice (*m. Longissimus thoracis*) 7 mm thick was collected from each carcass for proximate and fatty acid analysis. Treatments did not significantly differ in marbling score or marbling distribution ($P < 0.05$). USDA Choice slices had higher (more coarse) marbling texture when compared to USDA Select. Although dietary treatment affected marbling texture no consistent pattern was evident. Diets did not influence fat content, moisture or ash of the ribeye ($P > 0.05$). For treatments 0, 10, 30, 40 and 50% there were linear relationships between marbling score and fat percentage in the ribeye ($P < 0.05$) and all slopes were statistically similar at $P = 0.45$. Feeding MDGS linearly increased stearic, linoelaidic, linoleic, linolenic, PUFA and ω -6 fatty acids. As levels of MDGS increased, linear decreases were observed in all ω -7 fatty acids and cubic relationships were detected for eicosenoic, elaidic and total trans fatty acids. No treatment effects were observed for saturated fatty acids containing 6 to 14 carbons. Feeding MDGS increased PUFA, *trans*, and ω -6 fatty acids, had minimal effects on marbling texture, and did not alter the marbling-intramuscular fat relationship.

Key Words: beef, distillers grains, fatty acids

113 Regulation of matrix metalloproteases in macrophages by fatty acids is dependent on degree of saturation. R. B. Potu*, S. A. Adedokun, J. V. Adapala, M. Ward, and K. Ajuwon, *Purdue University, Department of Animal Sciences, West Lafayette, IN*.

Adipose tissue expansion is accompanied by increased infiltration of macrophages. Although macrophages are thought to play active part in the expansion process, the specifics of their contribution is unknown. Matrix metalloproteases (MMPs) play significant roles in adipose tissue expansion by causing the degradation of the adipose tissue matrix as the tissue expands. The importance of macrophages and nutrition as regulators of the MMPs in adipose tissue has not been previously determined. Therefore, using the RAW 264.7 macrophages, we examined with real-time PCR, the expression of MMP1, 3 and 13, in response to different fatty acids (palmitate, linoleic acid, docosahexaenoic acid, eicosapentaenoic acid and alpha-linolenic acid). Of the MMPs examined, we observed the most robust induction of MMP-13 by palmitate ($P < 0.050$). Other fatty acids were not as effective. We also observed a trend for induction of M2 macrophage marker (Arginase) by all fatty acids tested, suggesting that fatty acids may preferentially promote an M2 macrophage phenotype. Because MMP-13 preferentially degrades fibrillar collagens, its induction by saturated fatty acid, palmitate, may suggest a connection with saturated fatty acid induced adipose tissue expansion. This finding represents a significant mechanistic insight into the role of fatty acids in the regulation of efficiency of animal growth.

Key Words: matrix metalloproteases, macrophages, adipose tissue

114 Effect of dietary clay on diarrhea of weaned pigs experimentally infected with a pathogenic *E. coli*. M. Song^{*1}, J. A. Soares¹, Y. Liu¹, O. Osuna², C. W. Maddox¹, and J. E. Pettigrew¹, ¹University of Illinois, Urbana, ²Milwhite, Inc., Brownsville, TX.

A clay (hydrated sodium calcium aluminosilicate) that binds mycotoxins and is used as a flow agent has also been suggested to alleviate diarrhea in pigs. A study was conducted to evaluate the effect of this clay with 3 feeding regimens on diarrhea of weaned pigs experimentally infected with a pathogenic F-18 *E. coli* with toxins LT, STB and SLT-2 (1.32×10^{10} cfu per 3 ml oral dose daily for 3 days). Weaned pigs ($n = 48$, 6.9 ± 1.0 kg BW, 21 d old) were used in a 2×4 factorial arrangement (with or without an *E. coli* challenge; 4 diets). Pigs were housed in disease containment chambers for 16 days (4 days before and 12 days after the first challenge (d0)). The diets were a nursery basal diet (CON), 0.3% clay, 0.6% clay, and CON until the first challenge and then 0.3% clay. The diets did not include spray-dried plasma, antibiotics, or zinc oxide. The ADG, ADFI, and G:F were measured to d6 and 12. Diarrhea score (DS) (1, normal, to 5, watery diarrhea) was recorded for each pig daily. Feces were collected on d0, 3, 6, 9, and 12 and were plated on blood and MacConkey agars to differentiate *E. coli* β -hemolytic coliforms (HC) from total coliforms (TC). Their populations on blood agar were assessed visually using a score (0, no bacterial growth, to 8, very heavy bacterial growth) and expressed as a ratio of HC to TC scores (RHT). Blood was collected on d0, 6, and 12 to measure total and differential white blood cell counts (WBC), packed cell volume (PCV), and total protein. The clay treatments did not affect growth rate. In the challenged group, the clay treatments reduced ($P < 0.05$) average DS from d7 to 9 (2.06 vs. 2.50), from d10 to 12 (2.02 vs. 2.28), and from d0 to 12 (1.77 vs. 2.01), reduced ($P < 0.05$) RHT on d6 (0.60 vs. 0.87), and altered ($P < 0.05$) WBC on d12 (neutrophils (42 vs. 50%); lymphocytes (53 vs. 45%)) compared with the CON. The *E. coli* infection reduced ($P = 0.06$) ADFI from d0 to 6 (535 vs. 622 g/d) and increased ($P < 0.05$) PCV on d6 (39 vs. 36.8 %) compared with the unchallenged group. In conclusion, the clay reduced diarrhea and enhanced elimination of the pathogenic *E. coli*.

Key Words: clay, *E. coli*, weaned pigs

115 Supranutritional selenium and nutritional plane during gestation do not affect cortisol production in lambs. L. A. Lekatz^{*}, T. L. Neville, D. A. Redmer, L. P. Reynolds, J. S. Caton, and K. A. Vonnahme, North Dakota State University, Center for Nutrition and Pregnancy, Department of Animal Sciences, Fargo.

We hypothesized maternal supranutritional Se and nutrient restriction or excess would alter cortisol concentrations in the offspring of ewes. To examine the effects of maternal dietary Se and nutritional plane on cortisol concentrations and adrenal weight in lambs, 82 pregnant ewe lambs (52.2 ± 0.8 kg) were allotted randomly to one of six treatments in a 2×3 factorial. Factors were dietary Se [adequate Se ($9.5 \mu\text{g/kg}$ BW) vs. high Se ($81.9 \mu\text{g/kg}$ BW)], initiated at breeding and maternal nutrition [control (100% of NRC requirements) vs. restricted (60% of control), vs. excess (140% of control)], initiated at d 50 of gestation. At parturition lambs were removed from ewes and fed artificial colostrum for the first 20 h followed by ad libitum milk replacer until weaning (d 57). Lambs were maintained on common diets until necropsy (d 180). A

blood sample was obtained from each lamb at birth and d 7, 21, 35, 49, 57, 78, and 180 after birth. There were no interactions, or main effects of Se or nutritional level on lamb cortisol concentrations ($P > 0.12$). However, there was a day effect ($P < 0.01$) on cortisol concentrations. Cortisol was greatest at birth (170 ± 5.8 ng/mL), dropped sharply by d 7 (24.6 ± 1.9 ng/mL), gradually decreased until d 35 (9.52 ± 0.74 ng/mL) when cortisol levels remained stable through d 57 (9.49 ± 1.02 ng/mL). On d 78, cortisol concentrations increased (14.0 ± 0.75 ng/mL), followed by decreased concentrations on d 180 (10.9 ± 0.91 ng/mL). There was no effect of maternal diet ($P \geq 0.52$) on lamb adrenal weight at necropsy (2.29 ± 0.06 g). To determine total cortisol production throughout from birth to d 180, the area under the curve for each lamb was calculated. Cortisol area under the curve was not impacted ($P > 0.70$) by Se or plane of nutrition (1374 ± 40.9 ng/mL). We therefore reject our hypothesis and conclude that supranutritional Se and plane of nutrition during pregnancy do not affect cortisol production in offspring raised on a common postpartum diet.

Key Words: cortisol, gestational nutrition, offspring

116 Effects of increased feed intake during the late gestation on the reproductive performance in multiparous sows. W. S. Ju^{*}, Y. D. Jang, L. G. Piao, H. F. Long, and Y. Y. Kim, Seoul National University, Seoul, South Korea.

The objective of increasing feed intake (FI) in late gestating sow may be to increase the average birth weight of piglets. On the contrary, the increased feed intake in gestating sow can be related with the decrease of mammary cell numbers and FI in lactation as well as with the increase in concerns about feed cost and some disorders. The effects of increasing FI in late gestating sow are still controversial. Thirty-three Landrace-Large White crossbred sows were used to investigate the response of sow and their progeny to increased feed intakes during late gestation. Multiparous (6 and 7 parities) sows were fed corn-soybean meal-wheat bran diets, which contained 3,265 ME kcal/kg, 11.99% CP, and 0.75% Lys. The control group received 2.4 kg/d during the whole gestation period. Other treated groups were fed additional 0.3, 0.6, 0.9 kg/d of feed from d 90 to farrowing. All sows received the same diet ad libitum during a 3-week lactation period. Additional feed intake in late gestation increased sow weight gain (14.1, 18.9, 22.8, and 24.5 kg; linear, $P < 0.001$) and backfat thickness change (0.13, 0.25, 0.33, and 1.81; linear, $P = 0.003$) from d 90 to 110 of gestation. During the lactation period, treatment effects were not observed for the feed intake, the changes in BW and backfat thickness of sow, the number of pigs farrowed and weaned, birth weight and weaning weight per piglet or litter, and weaning to estrus interval. Colostrums and milk composition of sows were not affected by treatments. However, as gestation feed intake increased, CP (5.04, 5.05, 4.81, and 4.61; linear, $P = 0.009$) and solid-not-fat (10.62, 10.62, 10.52, and 10.39; $P = 0.018$) of sow milk at d 7 after postpartum was decreased linearly. The results indicated that increased feed intake during the late gestation period resulted in greater BW gain as well as the backfat thickness of gestating sows. The gestation feed intake also affected CP, and solid-not-fat in sow milk. However, no beneficial effects related with reproduction of multiparous sows were observed.

Key Words: gestation feed intake, reproductive performance, sows

117 In pigs myofiber hyperplasia is reduced due to intrauterine crowding. J. Bérard^{1,2}, C. E. Pardo^{1,2}, S. Béthaz¹, M. Kreuzer², and G. Bee^{*1}, ¹*Agroscope Liebefeld Posieux, Research Station ALP, Posieux, Switzerland*, ²*Department of Agricultural and Food Science, ETH-Zurich, Zurich, Switzerland*.

High prolificacy and increased fetal survival is associated with reduced uterine space. The aim of the study was to determine the impact of intra uterine crowding (IUC) using unilaterally hysterectomized-ovariectomized gilts (UHO), on organ and muscle development of the progeny at birth. In the study 7 UHO and 7 intact (C) Swiss Large White gilts were used. At farrowing 3 male and 3 female progeny with a low (> 0.8 and < 1.2 kg), high (> 1.6 kg) and medium (>1.3 and < 1.5 kg) birth weight (BtW) were sacrificed. Subsequently, internal organs, the semitendinosus (ST) and psoas major (M) were collected and weighed. Histological analyses were performed on the dark portion of the ST (STD) and the PM using mATPase staining after pre-incubation at pH 10.2. Myosin heavy chain (MyHC) polymorphism was determined in the PM using SDS-PAGE gel electrophoresis. Litter size was reduced ($P < 0.01$) by 35% and UHO-progeny tended ($P = 0.06$) to be lighter than C-progeny. Average BtW from the selected piglets did not ($P = 0.17$) differ among the experimental groups whereas PM and kidneys tended to be lighter ($P < 0.07$) in UHO- than C-progeny. Compared to C-progeny, the PM and the STD of UHO-progeny had fewer ($P \leq 0.05$) secondary and total myofibers as well as numerically fewer ($P \leq 0.15$) primary myofibers. The relative abundance of fetal MyHC was lower ($P = 0.02$) and that of type I MyHC was greater ($P = 0.09$) in piglets from UHO- compared to C-gilts. With increasing BtW, organ and brain weights increased ($P < 0.01$). By contrast myofiber hyperplasia was not ($P > 0.19$) affected by the BtW. Female progeny had fewer ($P < 0.08$) primary and secondary myofibers in both muscles than male progeny. In conclusion, regardless of the BtW IUC resulted in decreased weight of the kidney and PM and reduced muscle hyperplasia. The latter might ultimately impair postnatal growth and carcass characteristics.

Key Words: myogenesis, intra uterine crowding, pig

118 Effects of piglet birth weight and litter size on pre-weaning growth performance of pigs on a commercial farm. J. R. Bergstrom^{*1}, M. L. Potter¹, M. D. Tokach¹, S. C. Henry², S. S. Dritz¹, J. L. Nelssen¹, R. D. Goodband¹, and J. M. DeRouchey¹, ¹*Kansas State University, Manhattan*, ²*Abilene Animal Hospital, Abilene, KS*.

A total of 2,204 pigs (from 195 PIC-327 sired litters) were used to evaluate piglet birth weight (BiWt), litter size (LS), and pre-weaning piglet performance. All pigs born live (LB) over 22 d were identified with a numbered ear-tag. Within 18 h of parturition, each sow was assigned a body condition score (BCS), and the number of total born (TB), LB, and born dead (BD), as well as individual piglet gender and BiWt were recorded before movement to equalize LS. Litters were not provided creep feed. At weaning (~25-d of age), pigs were individually weighed and assigned a BCS (1=emaciated, 2=thin, or 3=full-bodied). For data analysis, pigs were grouped into 4 BiWt categories (<1.1, 1.1 to 1.5, 1.6 to 2.0, and >2.0 kg), and 3 TB categories (≤ 11 , 12 to 14, and ≥ 15). As expected, BiWt (0.9, 1.3, 1.7, and 2.1 kg) was greater ($P < 0.001$) for pigs of heavier BiWt categories. Pigs of heavier BiWt categories

were associated ($P < 0.02$) with a decreased number of TB (13.3, 13.1, 13.0, and 12.6) and LB (12.1, 11.9, 11.9, and 11.6). Pre-weaning ADG (172, 224, 248, and 267 g/d), weaning weight (5.2, 7.0, 7.9, and 8.8 kg), weaning BCS (2.69, 2.87, 2.89, and 2.93), and pre-weaning mortality (24, 10, 5, and 5%) were improved ($P < 0.001$) for pigs from heavier BiWt categories. For the 3 TB categories, BiWt (mean of 1.5 kg) was not different. Sow BCS (3.0, 3.0, and 3.1) was higher ($P < 0.001$) for TB category ≥ 15 . Litter LB (8.8, 12.0, and 14.8) and BD (0.6, 1.0, and 1.8) increased ($P < 0.001$) with greater TB categories. Pre-weaning ADG (234, 225, and 225 g/d) and weaning weight (7.4, 7.2, and 7.2 kg) were modestly improved ($P < 0.04$) for pigs from the lowest TB category. These data indicate that low-BiWt pigs had poorer pre-weaning growth and survivability. Although larger litters resulted in more low-BiWt pigs, the number of heavier-BiWt pigs also increased. As litter size increases, emphasis must be directed towards increasing BiWt and performance of low-BiWt pigs.

Key Words: birth weight, litter size, pigs

119 Effects of birth weight and gender on post-weaning performance of pigs in a commercial environment. J. R. Bergstrom^{*1}, M. L. Potter¹, M. D. Tokach¹, S. C. Henry², S. S. Dritz¹, J. L. Nelssen¹, R. D. Goodband¹, and J. M. DeRouchey¹, ¹*Kansas State University, Manhattan*, ²*Abilene Animal Hospital, Abilene, KS*.

A total of 1,995 pigs (PIC 327 sired) were used to evaluate the effects of birth wt and gender (barrow or gilt) on pig performance and carcass characteristics. For 22-d, all pigs born alive were identified at birth with a numbered ear-tag, and dam, gender, and birth wt were recorded. Pigs were weaned at approximately 25 d of age. All pigs were weighed at weaning (d 0) and on d 22, 44, 74, and 156. Carcass data were obtained from a subsample of 420 pigs harvested on d 167. For data analysis, individual birth wt was used to assign pigs to 7 birth wt categories (<1.2, 1.2 to 1.4, 1.4 to 1.5, 1.5 to 1.7, 1.7 to 1.8, 1.8 to 2.0, >2.0 kg). Therefore, data were analyzed as a 2x7 factorial to determine the effects of gender and birth wt category. Individual pig was the experimental unit, and dam, nursery room, and finisher room were used as random effects with weaning age as a covariate. As birth wt category increased, ADG and BW increased ($P < 0.001$) during all periods and overall (656, 702, 725, 732, 751, 766, and 771 g/d post-weaning; and 108, 117, 120, 122, 125, 128, and 129 kg final BW). Percentage of cull and light wt pigs at market (18, 11, 5, 7, 3, 2, and 2%) was also reduced ($P < 0.001$) as birth wt category increased. Although HCW (89, 93, 95, 95, 96, 96, and 98 kg) increased ($P < 0.001$) with increasing birth wt category, there were no differences in backfat depth (18 mm), loin depth (5.7 cm), and fat-free-lean (52%). Overall, post-weaning ADG (760 vs. 698 g/d), final BW (126 vs. 117 kg), HCW (98 vs. 91 kg), and backfat depth (20 vs. 16 mm) of barrows were increased ($P < 0.001$) compared to gilts; but the percent culls and pigs <97.5 kg (5 vs. 9%) and fat-free lean (50.9 vs. 53.2%) were reduced ($P < 0.001$) compared to gilts. Post-weaning mortality was not affected ($P > 0.57$) by birth wt category or gender. In summary, piglet birth wt and gender influence growth, and should be considered when identifying methods to optimize overall performance.

Key Words: birth weight, gender, growth

120 Effects of birth weight and dietary Paylean inclusion level on the growth performance and carcass composition of pigs. C. L. Puls*¹, M. Ellis¹, L. Kutzler¹, J. Killefer¹, F. K. McKeith¹, N. Williams², B. A. Peterson³, B. F. Wolter³, and S. N. Carr⁴, ¹University of Illinois, Urbana, ²PIC USA, Hendersonville, TN, ³The Maschhoffs, Carlyle, IL, ⁴Elanco Animal Health, Greenfield, IN.

The effects of birth weight and dietary Paylean inclusion level on growth performance and carcass composition were evaluated using 72 barrows in a 2 part study. Part I was from 3 wk post-weaning to 110 ± 2.0 kg BW as a RCBD with 1 treatment: Birth weight [Heavy, Medium, Light (average 1.5, 1.2, 0.9 kg, respectively)]. Pigs from the 3 birth weight classifications were selected from within the same birth litter. Part II was carried out from 110 ± 2.0 to 134 ± 3.2 kg BW as a RCBD using a 3 × 2 factorial arrangement of treatments: 1) Birth weight (Heavy, Medium, Light), and 2) Paylean inclusion level (0 and 5 ppm). Pigs were housed in individual pens and were weighed at birth, weaning, and every two weeks thereafter in Part I and weekly during Part II. In Part I, light birth weight pigs had lower ($P < 0.05$) ADG (0.98 vs. 1.02 vs. 1.05, respectively; SEM 0.016 kg), but similar ($P > 0.05$) ADFI and G:F as medium and heavy birth weight pigs. In Part II, there were no treatment interactions for growth traits; the effects of birth weight on growth performance were similar to Part I. There was no effect ($P > 0.05$) of birth weight on HCW, carcass yield, or LM area, however, tenth rib back fat was greater (2.8 vs. 2.5 vs. 2.5 cm, respectively; SEM 0.13; $P < 0.05$), and predicted fat-free lean was lower (49.0 vs. 50.5 vs. 51.2%, respectively; SEM 0.57; $P < 0.01$) for light than medium and heavy birth weight pigs. In Part II, feeding Paylean at 5 ppm increased ADG (1.06 vs. 1.25 kg; SEM 0.033; $P < 0.001$), G:F (0.300 vs. 0.358; SEM 0.0065; $P < 0.001$) and carcass yield (76.5 vs. 77.0%; SEM 0.16; $P < 0.05$), but had no effect on tenth rib back fat, LM area, or predicted fat-free lean. Results of this study confirm previous research on the effects of birth weight and Paylean on growth and carcass characteristics and suggest that the response to Paylean is similar across the birth weights evaluated.

Key Words: birth weight, Paylean, growth

121 Impact of feeding diets containing extruded flaxseed meal and vitamin E in finishing swine. A. D. Beaulieu*¹, J. F. Patience¹, R. T. Zijlstra², J. L. Aalhus³, and M. E. R. Dugan³, ¹Prairie Swine Centre, Inc., Saskatoon, SK, Canada, ²University of Alberta, Edmonton, AB, Canada, ³Agriculture and Agri-Food Canada Lacombe Research Centre, Lacombe, AB, Canada.

Successful marketing of pork enriched with omega-3 (n-3) fatty acids (FA) requires that other pork attributes are not reduced. The objective was to determine the impact of added dietary DL- α -tocopherol acetate (Vit E) on the incidence of rancidity or off-flavors in n-3 enriched pork products. Ninety-six pigs, divided into light (31.3±2.8 kg) or heavy (39.0±2.8 kg) initial BW were randomly assigned within gender to receive either diet (D) 1, control; D2, 5% extruded flaxseed; or D3, D2 plus 200 IU Vit E/kg diet, for 12 wks. D1 and D2 contained 11 IU/kg Vit E. D did not affect final BW (113.7 kg), ADG (1.04 kg/d), ADFI (2.61 kg/d), or G:F (0.40). Feeding flaxseed increased ($P < 0.001$) total n-3 FA in commercial cuts (e.g., primal plus 0.6 mm subcutaneous fat) however, with the exception of the loin (D1, 343; D2, 2154; D3, 2302 mg/100 g; D2 vs. D3, $P < 0.05$), n-3 FA were not changed by Vit E supplementation. D did not affect carcass or meat quality (e.g., pH, color, shear, drip loss) or primal weights; however flaxseed decreased ($P < 0.001$) fat hardness. D did not affect moisture, fat, or protein in hams;

however, flaxseed increased ($P < 0.05$) loin fat concentration. D did not affect tenderness, juiciness, flavor desirability, or off-flavor intensity of cooked chops. Flaxseed reduced ($P < 0.05$) pork flavour intensity. Stale flavor was higher ($P < 0.05$) for D1 than D2 or D3 (D1, 1.67; D2 or D3, 0.00 on a 9 pt scale) and other flavor descriptors (metallic, off-sour, barny, or rancid) were similar among D. D2 reduced ($P < 0.01$) flavor desirability and overall palatability of burgers prepared with 20% fat compared to D1 and D3. D2 increased ($P < 0.01$) percentage of panellists reporting burgers with a rancid (D1, 0.0; D2, 6.3; D3, 1.4) or 'other' flavor (D1, 3.4; D2, 15.3; D3, 6.4). Feeding extruded flaxseed reduced some quality attributes in ground pork. This was mitigated however, by increased dietary Vit E.

Key Words: omega-3, vitamin E, pork

122 Non-invasive prediction of pork loin tenderness. S. D. Shackelford*, D. A. King, and T. L. Wheeler, U.S. Meat Animal Research Center, Clay Center, Lincoln, NE.

The present experiment was conducted to develop a non-invasive method to predict tenderness of pork loins. Boneless pork loins (n = 901) were evaluated either on line on the loin boning and trimming line of large-scale commercial plants (n = 465) or at the U.S. Meat Animal Research Center abattoir (n = 436). Exposed longissimus on the ventral side of boneless loins was evaluated with visible and near-infrared spectroscopy (VISNIR; 450 to 1000 nm) using a commercial system that was developed for on-line evaluation of beef tenderness. Boneless loin sections were aged (2°C) until 14 days postmortem and two 2.54-cm thick chops were obtained from the 11th rib region. Fresh (never frozen) chops were cooked (71°C) and longissimus slice shear force (SSF) was measured on each of the two chops. Those two values were averaged and that value was used for all analyses. Carcasses were blocked by plant (n = 3), production day (n = 24), and observed SSF (Mean = 13.9 kg; SD = 3.7; CV = 26.8%; Range 6.4 to 32.4 kg) and one-half of the carcasses were assigned to a calibration data set (CDS), which was used to develop regression equations, and one-half of the carcasses were assigned to a prediction data set (PDS), which was used to validate the regression equations. A partial least-squares regression model was developed and loins were classified as "Predicted Tender" (PT) or "Not Predicted Tender" (NPT) if their VISNIR-predicted SSF was < 14.0 kg or ≥ 14.0 kg, respectively. ANOVA was used to determine the effect of VISNIR classification on SSF. The CDS and PDS had 61.9% and 60.9% of the loins classified as PT, respectively. For both the CDS and PDS, mean SSF was lower for PT than NPT ($P < 0.001$). Likewise, the percentage of loins with SSF ≥ 20 kg was lower for PT than NPT in the CDS (3.6 vs 8.1%) and PDS (1.8 vs 13.6%). These results clearly indicate that the VISNIR technology could be used to non-invasively classify pork loins on-line for tenderness.

Table 1. Effect of VISNIR tenderness class on the frequency distribution (%) of SSF values

Slice shear force class	CDS		PDS	
	PT (n = 279)	NPT (n = 172)	PT (n = 274)	NPT (n = 176)
5 to 10 kg	11.5	9.9	9.9	9.1
10 to 15 kg	65.2	51.7	65.7	49.4
15 to 20 kg	19.7	30.2	22.6	27.8
20 to 25 kg	2.2	6.4	1.5	9.1
25 to 30 kg	1.4	1.7	0.4	1.7
30 to 35 kg	0.0	0.0	0.0	2.8

Key Words: pork, tenderness, prediction

123 Effects of forage finishing level on sensory characteristics of Jersey beef. E. J. Arnett*, P. S. Kuber, F. L. Fluharty, S. J. Moeller, H. N. Zerby, and S. C. Loerch, *The Ohio State University, Columbus.*

The objective was to assess color stability and palatability of longissimus steaks obtained from strip loins of Jersey steers fed steam-flaked, corn-based diets (383 d) with either 12 (JL; n = 35) or 24% (JH; n = 38) forage (DM basis) and strip loin steaks from USDA Select⁺ and Choice⁻ carcasses (C; n = 40). Marbling values (MBV) were assessed between the 12th and 13th rib 1 d post harvest, then strip loins were removed and aged for 18 d. Three, 2.54 cm thick steaks were cut from the anterior end of the strip loin. The 1st steak was overwrapped in O₂ permeable film and placed in retail display (2 to 4°C) under continuous fluorescent lighting (1,600 lx). Minolta L*, a*, b* measurements were taken daily and a 6 member trained panel used a 7-point hedonic scale to visually evaluate lean color. The 2nd steak was used for Warner-Bratzler shear force (WBSF). A random subset (16 per treatment) was assessed by an untrained consumer sensory panel (n = 79) for tenderness, juiciness, flavor and overall acceptability using a 9-point hedonic scale (1 = like extremely and 9 = dislike extremely). Objective color (L*, a*, b* values) decreased ($P < 0.05$) with longer display across treatments. There were no differences among treatments for L*; however, JL had lower ($P < 0.05$) a* and b* values than JH and C. Subjective color scores indicated both JL and JH were less red ($P < 0.05$) than C. Objective tenderness (WBSF) was more desirable ($P < 0.05$) for JL and JH than C; however, no subjective tenderness differences were detected. The MBV was greater ($P < 0.05$) for JL and JH than C, and juiciness scores were more desirable for JL than JH and C; however, no differences were detected for flavor. Overall acceptability for JL was more desirable ($P < 0.05$) than that of C, while JH was intermediate, but not different than JL or C. Steaks from Jersey were equal to or more desirable than steaks from C carcasses for both color stability and palatability. Thus, value-added marketing opportunities may exist for steers with Jersey ancestry.

Key Words: Jersey, beef, sensory

124 Determination of fat percentage using CEM and folch fat extraction methods within marbling scores on beef *Longissimus* muscle. D. L. Dow*, B. R. Wiegand, M. R. Ellerseick, and C. L. Lorenzen, *University of Missouri, Columbia.*

Fat percentage determination in raw meat products has changed with technological advances. The development of rapid fat analysis methods has had an impact on the meat industry. The objective of this study was to determine the relationship of tenderness within marbling scores and determine fat percentage within marbling scores. Steaks (n = 119) were selected by USDA grading system using an E + V Vision Grading camera at a commercial beef plant during one day. One sample, approximately 5.08 cm, was cut from both sides of the carcass at the 13th rib and transported to University of Missouri meat lab. The steak from the right side of the carcass was allotted to Warner-Bratzler shear force and the steak from the left side, which was graded by the camera, was allotted to fat extraction. Warner-Bratzler shear force samples were cut into 2.54 cm steaks and aged for 14 d. Steaks allotted to fat extraction were trimmed of all external fat and twice ground using 8 mm and 4 mm grinding plates. The finely ground beef was then split into its allotted fat extraction methods. The two methods used in fat extraction were 2:1 chloroform/methanol (Folch) and microwave drying and nuclear magnetic resonance (CEM). Warner-Bratzler shear force values were not different between scores ($P > 0.05$). Regardless

of fat extraction method, fat percentage increased as marbling score increased ($P > 0.05$). Prediction equations for fat percentage using either CEM or Folch extraction methods were linear. The regression equation for CEM was fat percentage = $-3.46 + 0.016(\text{marbling score})$, R^2 of 0.824. Folch regression equation was fat percentage = $-3.42 + 0.019(\text{marbling score})$, R^2 of 0.816. When CEM and Folch methods were compared, both had the same slope but different intercepts ($P > 0.05$). Overall, tenderness was not affected by marbling score, but as expected, as marbling score increased fat percentage also increased regardless of fat extraction method.

Key Words: beef, fat extraction, marbling

125 Lactate/phosphate injection enhancement improved oxidation stability and tenderness of postmortem beef cuts packaged in high oxygen modified atmosphere. Y. H. Kim*, E. Huff-Lonergan, and S. M. Lonergan, *Iowa State University, Ames.*

A high-oxygen modified atmosphere packaging system (HiOx-MAP; 80% O₂ + 20% CO₂) has been extensively used because it maintains bloom and prevents microbial growth. However, this system may detract from color stability, flavor, and tenderness because of elevated oxidative conditions. The objective of this study was to determine the effects of lactate/phosphate enhancement on the development of tenderness, appearance, and lipid oxidation stability of specific underutilized beef round muscles packaged in HiOx-MAP. At 24 h postmortem, three bovine muscles (longissimus, semimembranosus, and adductor; n=10, respectively) were enhanced (120% of green weight) with either lactate (2.5%)/phosphate (0.3%) solution or water, packaged in HiOx-MAP, stored 9 d at 1°C, and then displayed for 7 d at 1°C. Type-3 tests of fixed effects for injection treatment, muscle differences, display time, and their interaction, and random effects for animal and animal by injection treatment were analyzed by using the Mixed Model procedure of SAS for ANOVA. Least squares means for all traits of interest were separated (F test; $P < 0.05$) by using least significant differences generated by the PDIF option. The lactate/phosphate injection significantly improved color stability (higher a* values) of all three bovine muscles throughout display period. Accumulation of lipid oxidation determined by 2- thiobarbituric acid-reactive substances values was also decreased ($P < 0.05$) in the lactate/phosphate injection that compared to the water treatment during storage and display period. Star probe values were lower ($P < 0.05$) due to enhancement in longissimus and semimembranosus steaks. There were no significant differences found in desmin and troponin-T degradation between treatments. The results suggest that lactate/phosphate enhancement have beneficial effects on color and lipid oxidation stability, and tenderness development of beef cuts under a HiOx-MAP condition.

Key Words: lactate/phosphate, tenderness, MAP

126 Control of *Listeria monocytogenes* on uncured, no-nitrate-or-nitrite-added frankfurters. K. D. Schrader*, J. G. Sebranek, J. C. Cordray, J. D. Dickson, and A. F. Mendonca, *Iowa State University, Ames.*

Sodium nitrite, utilized in the production of cured meats, is not permitted in natural and organic processed meats. Additionally, common additives such as sodium lactate, used for antilisterial control, are only tolerated for use at reduced levels for flavoring purposes. As a result, processors

have begun to employ alternative methods utilizing naturally occurring nitrates and nitrites found in vegetables to produce products labeled as uncured, no-nitrate-or-nitrite-added. The objective of this study was to determine if an increased risk for growth of *Listeria monocytogenes* (*Lm*) is associated with the ingredients and procedures used for natural and organic processed meats. Ten brands of commercially available frankfurters [2 conventionally cured controls (A,B), 3 alternatively cured including lactate (E,F,G), 4 alternatively cured without lactate (C,D,H,I) and 1 truly uncured (no addition of nitrite or lactate; J)] were purchased from retail outlets for chemical [pH, salt, residual nitrite, water activity (a_w)] and microbial analysis. A 5-strain mixture of *Lm*, was inoculated on the surface of the frankfurters to attain 3-log_{10} CFU/g, vacuum packaged and held at 10°C for 35 days. Rate of growth over the first 14 days was greatest ($P < 0.05$) for uncured brands I (truly uncured) and C (alternative cure without lactate) over all other brands except H (alternative cure without lactate). Brand H had a higher growth rate ($P < 0.05$) than brands F, D (alternative cure) and the controls (A, B). Brands that contained lactate (E, F, G) had growth rates that were similar ($P > 0.05$) to both controls (A, B). No differences ($P > 0.05$) existed among brands for pH, salt, and a_w but residual nitrite level differed among brands ($P < 0.01$). These results indicate a greater risk of *Lm* growth in alternatively cured natural and organic meat products. Additional intervention strategies to reduce the risk for *Lm* in natural and organic ready-to-eat meats are warranted.

Key Words: *Listeria monocytogenes*, sodium nitrite, nitrite-free meat

127 Prediction of live weight of growing-finishing pigs from simple body measurements. L. Ochoa*¹, M. Ellis¹, C. L. Puls¹, M. E. Mercedes¹, and B. A. Peterson², ¹University of Illinois, Urbana, ²The Maschhoffs, Carlyle, IL.

Two studies were carried out to evaluate the accuracy of simple body measurements to predict the live weight of growing-finishing pigs. Study I used 72 barrows from a Landrace-based line; Study II used 72 barrows from each of a Landrace-based and a Duroc-based line. Study I was carried out between 57.5 ± 7.1 and 134 ± 4.27 kg BW; Study II between 40.6 ± 4.9 and 126 ± 8.4 kg BW. In both studies, pigs were weighed every 2 wk and various body dimensions were taken on the live animal and on dorsal-and lateral-view photographic images taken at the time of weighing. Stepwise regression analysis was used to develop equations to predict live weight from body measurements. The highest R^2 values were obtained for regression equations based on live animal measurements such as chest circumference [$R^2 = 0.95$; Residual Standard Deviation (RSD) = 5.7 kg], and flank circumference ($R^2 = 0.94$; RSD = 6.5 kg). Regression equations based on live-animal measurements generally gave higher R^2 values than those based on measurements on the photographic images; e.g., in Study I the equation based on shoulder height gave $R^2 = 0.84$ (RSD = 10.5) for the measurement taken on the live animal vs. $R^2 = 0.26$ (RSD = 18.2) for the same measurement taken on the lateral image. Combining measurements to calculate body surface areas or volumes gave little improvement in R^2 when those for the respective individual measurements were already high. The results of this study suggest that regression equations based on simple body measurements can be used to accurately predict live weight of growing-finishing pigs.

Key Words: live weight prediction, linear body measurements, photographic image analysis

128 Evaluation of the prediction of alternative measures of pork carcass composition by three optical probes. A. Schinckel*, J. Wagner, J. Forrest, and M. Einstein, *Purdue University, West Lafayette, IN.*

The accuracy of three optical probes (HGP4, Hennessey Grading Probe, PG-100 and PG-200) to predict the carcass percentage of fat tissue-free lean (FFLM) was evaluated on 203 barrows and gilts. The optical probe backfat depths were more greatly correlated with each other ($P < 0.001$, $r = 0.963$ to 0.983) than the LM depths ($r = 0.695$ to 0.734). The optical probe backfat depths were related to fat-free lean percentage (FFL%) ($r = -0.82$ to -0.84 , $P < 0.001$). Optical probe LM depths were related ($P < 0.05$; $r = 0.23$ to 0.31) to FFL%. Fat-free lean percentage was predicted with residual standard deviations (RSD) of 3.7% for equations including last rib midline backfat thickness, 2.4 to 2.7% for equations including optical probe backfat and LM depth, and 2.3% for ribbed carcass measurements. Quadratic and cross-product variables of optical probe fat depth, LM depth and carcass weight were significant ($P < 0.05$) and reduced the RSDs for FFL% from 0.07 to 0.14%. Optical probe backfat and LM measurements can be used to predict alternative measures of carcass composition. The predicted relationships in FFL% to backfat depth were nearly identical for each optical probe.

Key Words: backfat, carcass composition, optical probe

129 Evaluation of the impact of errors in the measurement of backfat depth on the prediction of fat-free lean percentage. A. Schinckel*, M. Einstein, K. Foster, and B. Craig, *Purdue University, West Lafayette, IN.*

The development of regression equations to predict carcass composition assumes that the independent variables, such as backfat depth, are measured without error. Monte Carlo simulation was used to evaluate the impact of measurement error for backfat depth on the prediction of carcass fat-free lean percentage (FFL%) in pigs. In the simulation, FFL% was a linear function of carcass weight (CW) and actual backfat depth (ABFD). Measurement errors were generated such that the correlations (r_{BF}) of the measured backfat depth (BFD) and actual backfat depth ranged from 0.70 to 0.95. Two types of measurement errors were simulated: (1) errors with constant variance, and (2) errors whose SD's were proportional to the actual backfat depth. A total of 1000 replications of 1000 pigs were simulated. The absolute values of the regression coefficients and R^2 values of the equations decreased ($P < 0.01$) as r_{BF} decreased. When measurement errors were proportional to the actual backfat depths, prediction equations included an extraneous BFD² variable ($P < 0.05$) from 71.8 to 99.7% of the time. In addition, the probability of including an extraneous CW \times BFD variable ($P < 0.05$) increased from 10 to 45.6% as the magnitude of measurement errors increased. Equations developed from BFD's with measurement errors resulted in biased ($P < 0.01$) prediction of FFL%. The level and type of measurement errors should be evaluated when predicting carcass composition.

Key Words: carcass composition, measurement errors, prediction equations

130 Effect of birth weight on subsequent pig performance. J. O. Matthews*, S. B. Jungst, C. A. Jones, B. Fields, and A. A. Sosnicki, *PIC North America, Hendersonville, TN.*

Data from 464 litters (5,186 pigs) were used to determine the effect of birth weight (BW) on subsequent performance. Pigs were sired by boars (n = 43) from a synthetic line and were individually weighed within 24-h of birth. Two dam lines were used with an average parity of 3.67. Data were collected for determination of pig robustness, growth rates, carcass composition, and meat quality. Data were from six farrowing groups of pigs from the same sow farm and cross-fostering was very intensive. A total of 3,450 pigs were harvested at a commercial processing plant where data for carcass traits and pork quality were collected. Pre-weaning, nursery, and grow-finish survivability were improved (quadratic; $P < 0.05$) as BW increased with most of this improvement occurring below 1.36 kg of BW. Full value pigs marketed increased (quadratic; $P < 0.002$) and culls decreased (linear; $P < 0.003$) as BW increased with most of this change occurring below 1.36 kg of BW. Lifetime average daily carcass gain increased as BW increased (quadratic; $P < 0.0001$) particularly in pigs weighing less than 1.36 kg. Backfat depth decreased (linear; $P < 0.0002$) and loin depth increased (quadratic; $P < 0.002$) as BW increased, resulting in higher lean percentage (linear; $P < 0.0001$) as BW increased. Ham, belly, loin, and boneless loin weights when adjusted to a constant age at harvest all increased (quadratic; $P < 0.005$) as BW increased. Objective loin color measurements of Minolta L* (darker) and b* (less yellow) improved as BW increased (linear; $P < 0.0001$), but Minolta a* was not affected ($P > 0.05$) by BW. Subjective loin color (Japanese color score), loin pH, loin drip loss, and loin firmness also were not affected ($P > 0.05$), but loin marbling was decreased (linear; $P < 0.0001$) as BW increased. Piglets with lighter BW have poorer subsequent survivability, growth performance, and carcass characteristics and some aspects of pork quality are also affected by lighter BW.

Key Words: birth-weight, pig, growth, carcass, robustness

131 Evaluation of post-harvest *Salmonella* isolation and contamination of carcasses in vaccinated and non-vaccinated pigs. T. Frana*¹, L. McDeid¹, L. Terry¹, J. Kolb², J. Husa², and A. Oropeza-Munoz², ¹*Iowa State University, Veterinary Diagnostics and Production Animal Medicine, Ames,* ²*Boehringer Ingelheim Vetmedica, Inc., Ames, IA.*

This study compared *Salmonella* isolation and carcass contamination rates of *Salmonella*-vaccinated versus non-vaccinated pigs using different methods of *Salmonella* detection. Market weight animals were randomly selected from groups that either had been previously vaccinated with a *Salmonella* Choleraesuis vaccine (Enterisol-; 54) or had not been vaccinated. Samples from one hundred and sixty two pigs (vaccinated = 79, non-vaccinated = 83) were collected along with 25 pooled environmental samples (pen, truck, lairage). Animal sample types included ileocecal lymph nodes, peritoneal sponges and shoulder sponges. Initially, swabs from all samples were used to directly inoculate hektoen enteric (HE) plates and Tetrathionate enrichment broth (Tet). Later after freezing at -80°C, lymph nodes were homogenized in Phosphate Buffered Saline and enriched using Tet and Rappaport-Vassiliadis (RV) or Buffered Peptone Water (BPW) + novobiocin and RV. Enriched samples were plated onto brilliant green and XLT4 media. Suspect colonies were subcultured on HE and tested with several biochemical reactions. Positive *Salmonella* isolates were confirmed by serogrouping and serotyping. *Salmonella* was not

isolated from peritoneal or shoulder sponges or from lymph node swabs. *S. Anatum* and *S. Muenchen* were isolated from 2 environmental pen samples. *S. Mbandaka* was isolated from homogenized lymph nodes using both enrichment methods. Five samples were positive with the BPW + novobiocin and RV method and 3 same samples were positive using the Tet and RV method. All 5 *Salmonella* positive samples were from animals that were not previously vaccinated (P -value = 0.03, Fisher's Exact Test). In this study, prior vaccination against *Salmonella* decreased *Salmonella* isolation at slaughter. Tissue homogenization followed by BPW + novobiocin and RV enrichment was the most sensitive method used to detect *Salmonella* with culture.

Key Words: *Salmonella*, bacteriology, vaccine

132 Meat quality and retail shelf-life of pork from pigs fed dried distillers grains with solubles (DDGS), conjugated linoleic acid (CLA) and a ractopamine (RAC) program. D. Pompeu*, J. W. Rickard, G. D. Gerlemann, R. B. Hinson, M. E. Briscoe, B. R. Wiegand, and G. L. Allee, *University of Missouri, Columbia.*

This study evaluated the effects of the inclusion of DDGS, CLA and RAC on meat quality of fresh pork loins. All protocols were performed according to University of Missouri ACUC Guidelines. Barrows (n = 72) of PIC 337 genetics were blocked by weight and assigned randomly within a 2 × 2 × 2 factorial arrangement yielding a CRBD with 9 replications per treatment. Factors included DDGS (0 or 20%), CLA (0 or 0.6%), and RAC (0 or 7.4 ppm). Pigs were individually fed for 28 d before slaughter being the experimental unit. Pigs (136 Kgs ± 7.98) were humanely slaughtered at the University of Missouri Red Meats Abattoir under USDA-FSIS inspection. After 24 hours of chilling, loins were removed from the right side of each carcass and samples were collected for the following analyses: cooking loss (CL), shear-force (SF), water holding capacity (WHC), proximate analysis (fat and moisture) and drip loss (DL). Furthermore, 1 chop of each loin was removed and placed on individual trays (with an absorbent pad), and overwrapped with oxygen-permeable, PVC film. Trays were placed in a retail cooler at a temperature of 4°C for 7 days. Minolta color of the chops was evaluated on days 1, 4 and 7 and package purge (PP) was also determined. The inclusion of DDGS, RAC and CLA to the diets did not have a significant effect on CL ($P > 0.81$), SF ($P > 0.49$), WHC ($P > 0.33$), fat ($P > 0.43$) and moisture percentage ($P > 0.53$). PP was only affected by CLA inclusion which significantly ($P < 0.05$) increased PP from 4.47 to 5.41%. DL was affected only by the inclusion of RAC which increased ($P < 0.05$) from 3.04 to 3.69%. Furthermore, lightness (L*), redness (a*) and yellowness (b*) of the chops were not affected by the inclusion of DDGS ($P > 0.41$), RAC ($P > 0.14$) and CLA ($P > 0.74$) when compared within analyzed days. Thus, DDGS, RAC and CLA could be added, at the levels described, to swine diets during growing-finishing phases without major effects on quality of fresh loin.

Key Words: pork, shelf-life, CLA

133 Effects of feeding high levels of wet distillers grains and straw on lipid oxidation and color stability of beef. S. Pokharel*, C. Calkins, A. de Mello Jr., S. Senaratne, J. Hinkle, T. Carr, and G. Erickson, *University of Nebraska, Lincoln.*

This research was carried out to measure the effect of feeding high levels of wet distillers grains and straw on shelf life of aged beef. Cattle

were fed one of 6 diets (corn; 40% DG/0% straw; 70% DG/8% straw; 77.5% DG/9% straw; 77.5% DG/17% straw, and 85% DG/10% straw – DM basis). USDA Choice strip loins (m. *Longissimus lumborum*), 9-15 per treatment, (IMPS # 180 PSO2; NAMP, 2007) were cut into 3 steaks (2.54 cm- thick) each after 20 days of postmortem aging. One steak from each loin was vacuum packaged for laboratory analysis of fatty acids, thiobarbituric acid reactive substances (TBARS), and proximate analysis. One steak was overwrapped with oxygen-permeable, polyvinyl chloride film and placed in a retail display maintained at $\pm 2^\circ\text{C}$ for 7 days for objective and subjective (trained panel) color evaluation, and TBARS at the conclusion of the display period. One steak from each loin was cut in half (due to limitations in retail shelf space). Half of each steak was overwrapped with oxygen-permeable film and stored under retail display for 4 d prior to TBARS analysis. The statistical analysis was carried out by GLIMMIX procedure of SAS with a split plot design. There was no treatment by day interaction ($P > 0.05$) for TBARS. The treatment having 70% DG/8% straw had the highest TBARS, followed by 77.5% DG/17% straw, 77.5% DG/9% straw, and 85% DG/10% straw. There were significant ($P < 0.05$) treatment-by-day interactions for discoloration and L^* , a^* , and b^* instrumental color. There was a trend in decreasing level of a^* (redness) from day 0 to day 7 where corn fed cattle had the highest a^* reading at the end of retail display followed by 40% DG, 0% straw. Level of DG increased the amount of TBARS, an indication of more polyunsaturated fatty acids in steaks. Meat from cattle fed high levels of DG discolored more rapidly than meat from cattle fed lower levels of DG. These data indicate that precautions against oxidation and discoloration are needed when cattle are fed high levels of DG, the meat is aged, and subjected to retail display in oxygen-permeable packaging.

Key Words: beef, color, distillers grain

134 Sequential feeding of β -agonist growth promotants in cull beef cows. M. J. Daniel*, M. E. Dikeman, J. Jaeger, J. A. Unruh, T. A. Houser, and B. L. Goehring, *Kansas State University, Manhattan.*

Our objective was to determine the effects of implanting and feeding a concentrate ration plus supplementation with a sequence of β -agonist growth promotants on cow performance and carcass characteristics. Sixty cull cows were implanted with Revalor-200, assigned to 1 of 4 treatments, and fed a concentrate ration for 74 d: C = fed a concentrate ration only; R = supplemented with ractopamine-HCL (RAC) for the last 25 d; Z = supplemented with zilpaterol-HCL (ZIL) for the last 20 d; RZ = supplemented with RAC for 25 d followed by ZIL for the last 20 d. For Z and RZ treatments, cows had a 3 d withdrawal from ZIL prior to harvest. Cows were allotted with 5 cows per pen creating 3 replicate pens per each treatment. Live weights were collected on d 1, 24, 52, and 72. Hot carcass weights were recorded at harvest; at 72 h postmortem, carcass traits were evaluated. Carcasses from cows in the Z and RZ treatments tended to have heavier HCW and larger ribeyes. Carcasses from cows in the Z treatment tended to have the most desirable lean color scores ($P = 0.27$), and carcasses of cows from the RZ treatment tended to have the highest ($P = 0.30$) marbling scores. Economic analysis was conducted by comparing initial cow value with harvest cow value while factoring in feed, transportation, and treatment costs. No significant differences were found in net revenue among treatments. However, cows increased in value from \$54.50/cwt to \$77.02/cwt over the 74 d feeding period. Although there were no statistical differences in any performance or carcass traits evaluated,

treatments that included ZIL tended to have increased weights and increased muscling without sacrificing other carcass characteristics.

Table 1. Performance and Carcass Traits

Item	C	R	Z	RZ	P-value
Initial Weight, kg	527	522	521	524	0.93
Final Weight, kg	639	628	647	648	0.53
ADG, kg	1.56	1.48	1.74	1.72	0.63
HCW, kg	370	372	385	390	0.42
Dressing percent, %	59.0	59.3	59.7	60.2	0.58
Adjusted fat thickness, cm	0.89	0.94	0.86	0.97	0.92
Ribeye area, cm ²	83.6	85.8	93.5	91.4	0.49
Yield grade	2.6	2.6	2.2	2.5	0.46
Marbling score ¹	383	357	373	403	0.30
Lean color ²	5.4	5.3	5.4	4.4	0.27

¹Marbling score scale: 300=slight00, 400=small00, etc.

²Lean color scale: 1=pale red, 7= dark red

Key Words: β -agonist, zilpaterol-HCL, beef cows

135 There is little benefit of acid enhancement at a low injection rate on the fresh and cooked color of dark-cutting beef. J. K. Apple*¹, J. T. Sawyer¹, J. -F. Meullenet², M. D. Wharton¹, and J. W. S. Yancey¹, ¹University of Arkansas, Department of Animal Science, Fayetteville, ²University of Arkansas, Department of Food Science, Fayetteville.

Dark-cutting (DC) strip loins (average pHu = 6.70) were used to compare the effects of lactic acid (LAC) enhancement on fresh and cooked beef color, as well as sensory attributes, to normal pH, low Choice strip loins (CH; average pHu = 5.37). All s.c. fat, as well as the *gluteus medius* and accessory muscles, were removed from the LM of both CH and DC strip loins, and transversely sectioned into 2 equal-length sections. The DC sections (n = 46) were subsequently assigned at random to either a non-enhancement control (n = 9) or enhanced with either 0.15 or 0.35% LAC (n = 18/treatment) at a target of 105% of the raw section weight; the CH sections (n = 9) served as a non-enhanced, positive control. Steaks from each section were packaged in an 80% O₂/20% CO₂ modified atmosphere, placed in open-topped, coffin-chest display cases, and displayed for 5 d. Additional steaks from each section were cooked to an internal endpoint temperature of 71°C for cooked color analyses and descriptive flavor/texture attribute evaluations. Neither 0.15 nor 0.35% LAC-enhancement altered ($P > 0.05$) post-enhancement pH of DC sections. Raw CH steaks had greater ($P < 0.05$) a^* and b^* values, as well as Japanese color scores, than steaks from non- and LAC-enhanced DC strip loins across the first 3 d of simulated retail display (LAC \times retail display duration; ($P < 0.01$)). Also, CH steaks received the highest ($P < 0.05$) cooked color and internal doneness scores, whereas panelists noted that first-bite hardness and hardness of mass were more ($P < 0.05$) intense in CH than DC steaks, regardless of LAC-enhancement. Cooked CH steaks were rated higher ($P < 0.05$) for sour, cooked beef, and roasted/caramelized flavors than steaks from non- and LAC-enhanced DC sections, but non-enhanced DC and 0.15% LAC-enhanced steaks had a more ($P < 0.05$) intense soap flavor than either CH or 0.35% LAC-enhanced steaks. It is possible that the low enhancement rate of 105% contributed as much to the lack of any improvements in fresh and cooked color as did the low LAC levels in the acid marinades.

Key Words: dark-cutting beef, lactic acid enhancement, color

136 Lactic acid enhancement can improve the fresh and cooked beef color of dark-cutting beef. J. K. Apple^{*1}, J. T. Sawyer¹, J. -F. Meullenet², M. D. Wharton¹, and J. W. S. Yancey¹, ¹University of Arkansas, Department of Animal Science, Fayetteville, ²University of Arkansas, Department of Food Science, Fayetteville.

Dark-cutting strip loins (average pHu = 6.79) were used to compare the effects of enhancement with 0.35 or 0.50% lactic acid (LAC) on fresh and cooked beef color, as well as sensory attributes, to normal pH, low Choice strip loins (average pHu = 5.58). All s.c. fat, as well as the *gluteus medius* and accessory muscles, were removed from the LM of both CH and DC strip loins, and transversely sectioned into 2 equal-length sections. The DC sections (n = 46) were subsequently assigned at random to either a non-enhancement control (n = 9) or enhanced with either 0.35 or 0.50% LAC (n = 18/treatment) at a target of 112% of the raw section weight; the CH sections (n = 9) served as a non-enhanced, positive control. Steaks from each section were packaged in an 80% O₂/20% CO₂ modified atmosphere, placed in open-topped, coffin-chest display cases, and displayed for 5 d (2.6°C and 1,600 lux lighting). Additional steaks from each section were cooked to an internal endpoint temperature of 71°C for cooked color analyses and descriptive flavor/texture attribute evaluations. Post-enhancement pH of DC beef was decreased ($P < 0.05$) by LAC-enhancement, with pH values similar ($P > 0.05$) between CH sections and 0.50% LAC-enhanced DC sections. Raw steaks from CH sections had greater ($P < 0.05$) L*, a*, and b* values and Japanese color scores than non- and LAC-enhanced DC steaks; however, mean Japanese color scores of CH steaks were only 0.7 and 0.4 units greater than steaks from 0.35 and 0.50% LAC-enhanced DC steaks, respectively. Cooked color and degree of doneness scores for CH steaks and steaks from 0.50% LAC-enhanced DC sections did not ($P > 0.05$) differ when cooked to 71°C. Even though there were a number of significant ($P < 0.05$) texture and flavor differences, the values were numerically similar. Because the persistent red/pink cooked color of DC was virtually eliminated by 0.50% LAC-enhancement, LAC-enhanced DC beef may be suitable for food-service markets; however, results from this study suggest that the fresh color of DC beef can be improved to that similar of CH beef by postmortem lactic acidification.

Key Words: dark-cutting beef, lactic acid enhancement, color

137 Color stability and tenderness variations within the gluteus medius from beef top sirloin butts. J. B. Machete, J. K. Apple*, R. J. Stackhouse, T. M. Johnson, C. A. Keys, and J. W. S. Yancey, University of Arkansas, Department of Animal Science, Fayetteville.

Beef top sirloin butts (n = 48) were selected at a large commercial slaughter facility based on USDA quality grade (QG; upper 2/3 USDA Choice or USDA Select) and USDA yield grade categories (YG; 1 and 2 or 4 and 5) to measure the instrumental color and shear force (WBSF) variation within the *gluteus medius* (GM). After aging 14 d from the box date at 2°C, 2.5-cm-thick steaks were cut from the GM, with 2 steaks removed from the anterior (ANT), middle (MIDD) and posterior (POST) sections of the GM. One steak from each section was cut into 3 equal length steaks and designated as lateral (LAT), central (CENT), and medial (MED) portions, placed onto foam trays with absorbent pads, over-wrapped with an O₂-permeable, PVC film, and stored under simulated retail display conditions for 7 d. The second steak of each location pair was cooked to 71°C in an air-impingement oven for WBSF determinations. The LAT and MED portions of Select steaks were lighter (greater L* values; $P < 0.05$) than the LAT and MED portions of top Choice steaks (QG × within-steak position; $P < 0.01$), whereas top Choice steaks had greater ($P < 0.05$) a* and b* values than Select steaks each day of display (QG × display day; $P < 0.01$). Furthermore, the MED portion of MIDD steaks and the LAT portion of POST steaks had the greatest ($P < 0.05$) b* values, and the LAT portion of ANT steaks had the least ($P < 0.05$) b* values (steak location × within-steak position, $P < 0.01$). Cooking losses did not ($P = 0.53$) differ among ANT-, MIDD- and POST-located steaks, but cooking loss percentages were greatest ($P < 0.05$) in the MED portion and least ($P < 0.05$) in the CENT portion of the GM steaks. Neither QG ($P = 0.13$) nor YG category ($P = 0.48$) affected WBSF values, but the CENT portion of ANT steaks received the lowest ($P < 0.05$), and the MED portion of MIDD steaks received the greatest ($P < 0.05$), WBSF values (steak location × within-steak position, $P < 0.01$). Results of this experiment indicate definite tenderness and color stability gradients within the GM.

Key Words: top sirloin butt, beef, color stability

Nonruminant Nutrition

138 Effect of chromium propionate supplementation on growth performance and carcass traits from wean to finish pigs. L. Greiner^{*1}, R. Hinson², G. Allee², J. Connor¹, A. Yersin³, A. Lamptey³, and B. Kremer³, ¹Innovative Swine Solutions, LLC, Carthage, IL, ²University of Missouri, Columbia, ³Kemin Industries, Des Moines, IA.

A study was conducted starting February of 2009 in a commercial research facility located in Northeast Missouri to evaluate the effect of chromium propionate on growth performance and carcass characteristics of wean to finish pigs. One thousand (PIC C29X327) mixed sex pigs were weaned at 19 ± 2 days. Pigs were placed in pens of 23 and were blocked by weight and sex. Groups of pigs were maintained throughout the study. The treatments tested in this experiment were 0/0, 200/0ppb, 0/200ppb, and 200/200ppb of chromium supplementation in the nursery and grow-finish phases, respectively. Pigs were fed Paylean at 4.5 g/ton approximately 2 weeks prior to market. Diets included corn and soybean meal and included 30% dry distillers grain with solubles (DDGS) in the nursery and gradually decreased to no DDGs in the finisher. Data was

analyzed as a repeated measures design using Proc Mixed. The model consisted of sex, treatment, and period and all interactions. Overall average daily gain from d 0-146 (0.722, 0.724, 0.728, and 0.730 kg/d, $P \geq 0.6$) and feed intake (1.707, 1.705, 1.721, and 1.738 kg/d, $P \geq 0.75$) was not significant between treatments. However, there were strong sex by treatment interactions in the finishing period on average daily gain (0.861, 0.986, 0.922, .947 kg/d, $P \leq 0.01$) and feed intake (2.251, 2.472, 2.397, 2.450 kg/d, $P \leq 0.01$), respectively, in barrows from d 132-146 of the study when chromium was added. In addition, there was significant improvement in average daily gain in barrows from d 0-146 when chromium was fed throughout the experiment (0.727, 0.739, 0.732, 0.748 kg/day, $P \leq 0.06$). The addition of chromium did not influence carcass value. In conclusion, the addition of chromium fed throughout the grow-finish period resulted in improved barrow performance due to the increase in feed intake.

Key Words: chromium propionate, grow finish, pig

139 Replacing inorganic minerals with organic forms at reduced levels in growing pigs. J. Taylor- Pickard*¹, L. Nollet¹, and R. Geers², ¹Alltech Biotechnology Centre, Dunboyne, Co. Meath, Ireland, ²Katholieke Universiteit Leuven, Leuven, Belgium.

Feeding lower levels of minerals in a more bioavailable form is important in reducing potential pollution from the manure resulting from intensive pig farming, as well as maintaining higher tissue reserves in the animals, facilitating growth and health. A trial using 136 crossbred male and female pigs was conducted to determine the effect of replacing inorganic minerals in the diet with organic forms (Bioplex and Sel-Plex, Alltech Inc, USA) at lower levels on growth performance and carcass characteristics. Diets were based on commercial wheat-soy formulations. The control treatment contained inorganic minerals (100 ppm zinc sulphate and iron sulphate, 15 ppm copper sulphate, 40 ppm manganese oxide and 0.3 ppm sodium selenite), whereas the test diet contained chelated minerals, with zinc, iron and manganese included at lower levels (40 ppm zinc, 40 ppm iron, 15 ppm copper, 20 ppm manganese and 0.3 ppm organic selenium from selenised yeast). Body weight and feed intakes were measured from weaning (~22 kg) to slaughter weight at 102 days after the start of the trial (~105 kg). Carcass characteristics were measured at slaughter. The results showed that growth performance was maintained and, in the case of gilts, increased for those fed the organic mineral diet. Slaughtering yield was not significantly different between treatments. Meat quality parameters were not significantly affected by the replacement of inorganic minerals with lower levels of organic forms, although backfat thickness and percentage lean meat were significantly improved ($P < 0.05$) for the pigs fed the organic mineral diet (table 1). The data demonstrated that lower levels of organic forms of minerals can be used in growing pig diets without any loss in performance, and benefits in growth and meat characteristics can be obtained.

Table 1. Carcass parameters of growing pigs fed either inorganic or organic forms of minerals(data corrected for bodyweight at d 1 of trial)

Carcass parameter	Inorganic control	Organic minerals
Carcass weight (kg)	82.5	81.8
Slaughter efficiency (%)	77.1	76.9
Ham angle(°)	43.7	44.4
Backfat thickness(mm)	13.5 ^a	12.2 ^b
Lean meat(%)	60.0 ^a	60.7 ^b
Meat Building Index (MBIc) ¹	3.47	3.34

^{a,b}Means not sharing a letter differ significantly ($P < 0.05$).

¹Ratio between meat content and conformation of the pig

Key Words: inorganic, minerals

140 Performance and carcass characteristic improvements of replacement of inorganic minerals by organic forms in growing pig diets. J. Taylor- Pickard*¹, L. Nollet¹, and R. Geers², ¹Alltech Biotechnology Centre, Dunboyne, Co. Meath, Ireland, ²Katholieke Universiteit Leuven, Leuven, Belgium.

Minerals are available, broadly, in two forms: inorganic (such as oxides and sulphates) and organic (chelated to small peptides or amino acids via chemical or biochemical means). Various experiments have shown improvements in productive performance in animals receiving minerals that have been chelated to certain length peptides, due to improved uptake from the digestive tract and better distribution and utilisation

within the body (Coffey et al., 1994). The following experiment compared the performance and carcass quality of pigs from weaning to slaughter weight fed either standard levels of inorganic minerals (15 ppm Cu (sulphate), 100 ppm Zn (sulphate), 40 ppm Mn (oxide), 100 ppm Fe (sulphate) 0.3 ppm Se) or lower levels of organic minerals (Alltech Inc, USA) at in feed (15 ppm Cu, 40 ppm Zn, 20 ppm Mn, 40 ppm Fe, 0.3 ppm Se as selenised yeast (Sel-Plex)). This trial was conducted using 134 pigs from weaning (21 kg) to finishing (105 kg) fed wheat-soy based commercial feeds formulated with either inorganic minerals or lower levels of organic forms. Pigs fed the organic mineral diet has significantly higher ($P < 0.05$) average daily gain (ADG) compared to those receiving the inorganic control diet between day 31 and 64 of the trial period. The pigs receiving the organic minerals had greater cumulative growth rates and yielded 2 kg extra carcass weight, had higher slaughter efficiency ($P < 0.05$) and greater ham width ($P < 0.05$; table 1). These results indicated that chelated minerals can successfully replace inorganic forms in growing pig diets, and, even when included at lower inclusion levels, can result in performance benefits.

Table 1. Carcass parameters of growing pigs fed either inorganic or organic forms of minerals(data corrected for bodyweight at d 1 of trial)

Carcass parameters	Inorganic control	Organic minerals
Carcass weight (kg)	81.1	83.2
Slaughter efficiency (%)	76.6 ^a	77.3 ^b
Ham width (mm)	205 ^a	208 ^b
Lean meat (%)	62.4	62.7
Type number ¹	1.99 ^a	1.88 ^b
Meat Building Index (MBIc) ²	3.54	3.38

^{a,b}Means not sharing a letter differ significantly ($P < 0.05$).

¹Conformation of the hams.

²Ratio between meat content and conformation of the pig.

Key Words: inorganic, minerals

141 Dietary anionic mineral (CAD-MATE) additions affect apparent calcium retention in prepartum sows. C. Darriet¹, D. E. Axe², and T. D. Crenshaw*¹, ¹University of Wisconsin, Madison, ²Granco Minerals, Petersburg, VA.

Adding anionic salts to acidify the diets of prepartum dairy cows is a commonly used technique to lower the incidence of milk fever. Anionic diets improve Ca homeostasis by promoting mobilization of bone mineral reserves. Mineral balance and renal responses during dietary acid-loads in gestating sows are not well characterized. The anionic mineral supplement CAD-MATE (Granco Minerals, Petersburg, VA) was added to a standard corn-SBM gestation diet at 0, 1.5, or 2.5% to provide 33, -116, and -216 mEq/kg diet (Na + K - Cl - S). Twelve multiparous gestating sows (Landrace x Large White) were fed 1 of 3 diets for 12 d. Three 24-h urine and fecal samples were collected during the last 3 days of the experiment. Mineral analyses were conducted on composites to quantify mineral balance in response to an acid load. Urinary pH decreased with incremental additions of CAD-MATE (range 6.65-5.59). Urinary SO₄ (range 134-396 mEq/d) and NH₄ (range 83.5-323.2 mEq/d) excretion increased with increased CAD-MATE. Urinary Mg, Na, and K excretion were not significantly different amongst treatments. Fecal excretions of Ca (range 471-624 mEq/d), Mg (range 170-362 mEq/d) and P (range 245-295 mmol/d) increased at higher CAD-MATE levels ($P < 0.05$), but fecal K, Na, Cl excretions did not differ amongst treatments. Apparent Ca retention decreased with CAD-

MATE supplementation while apparent Mg and Cl retention increased ($P < 0.05$). In conclusion, at 1.5 and 2.5% diet inclusion, CAD-MATE resulted in significant increases in urinary and fecal Ca excretions and decreased apparent Ca retention suggesting increased mobilization of body Ca pools in parturient sows.

Table 1. Dietary CAD-MATE, %

	0	1.5	2.5	SEM
Urine pH	6.65 ^a	5.64 ^b	5.59 ^b	0.1
Urine NH ₄ , mEq/d	84 ^a	256 ^b	323 ^c	13.7
Ca retention, mEq/d	204 ^a	122 ^b	68 ^b	29.0
Mg retention, mEq/d	9 ^a	47 ^b	61 ^b	13.7
Cl retention, mEq/d	-54.0 ^a	-3.0 ^b	80.1 ^c	15.8
P retention, mmol/d	115.6	95.0	75.1	14.8

^{a-c}Means without a common superscript within a row differ ($P < 0.05$).

Key Words: swine, dietary cation-anion balance, calcium balance

142 Benefits of an organic copper source (Cu-(HMTBA)₂) on growth performance and carcass traits in finisher pigs. J. Zhao*, R. Harrell, P. Fisher, C. Atwell, J. Richards, and M. Vazquez-Anon, *Novus International Inc., St. Charles, MO.*

The objective of this study was to investigate a dose titration of Cu-(HMTBA)₂ (Mintrex Cu; Novus International) compared to high CuSO₄ in grower-finisher pigs. A total of 1048 pigs were allotted to 6 treatments with 8 replicates per treatment. The treatments included a negative control with 4 ppm Cu from CuSO₄, a positive control at 160 ppm from CuSO₄, and Mintrex Cu at 20, 40, 80, and 160 ppm. All pigs were fed a Cu deficient diet for the first 21 days then switched to experimental diets for 79 days. Corn-Soybean meal-DDGs diets were used and Paylean (4.5g) was added in the last 20 days. No benefit of CuSO₄ was observed except during the first 21 days following the depletion period in that CuSO₄ improved ADG (0.932 vs. 0.988 kg), ADFI (2.405 vs. 2.486 kg) and G:F (0.389 vs. 0.398) compared to the negative control ($P < 0.05$). Pigs fed incremental Mintrex Cu resulted in increased ADG and G:F up to 80 ppm and no further improvement was observed at 160 ppm. Pigs fed 80 ppm Mintrex Cu tended to have improved overall ADG ($P = 0.07$), heavier body weight ($P = 0.07$), and increased carcass weight ($P = 0.006$) compared to all others. Overall ADG were 0.858, 0.852, 0.840, 0.856, 0.872, 0.857 kg for the negative control, 160 ppm CuSO₄, Mintrex at 20, 40, 80, and 160 ppm, respectively. Pigs fed 80 ppm Mintrex weighed 2kg more ($P = 0.07$) and were 2 kg heavier in carcass ($P = 0.006$) compared to pigs fed either the negative control or 160 ppm CuSO₄. In addition, loin depth was increased with increased Mintrex Cu supplementation with pigs fed 80 ppm Mintrex having the greatest loin depth ($P = 0.008$) compared to others. In summary, 80 ppm Mintrex Cu improved growth performance and carcass traits (heavier carcass weight and greater loin depth) compared to 160 ppm CuSO₄ and the negative control.

Table 1. A dose titration of Mintrex Cu on performance and carcass traits in finisher pigs

Treatment	Negative control	160ppm CuSO ₄	20ppm Mintrex	40ppm Mintrex	80ppm Mintrex	160ppm Mintrex	SEM	P-value
Initial BW, kg	52.57	52.58	52.52	52.60	52.54	52.56	0.30	1.00
Final BW, kg	117.54 ^b	117.86 ^b	117.28 ^b	118.22 ^{ab}	119.67 ^a	118.91 ^{ab}	0.60	0.07
Overall ADG, kg	0.858 ^{ab}	0.852 ^b	0.840 ^b	0.856 ^{ab}	0.872 ^a	0.857 ^{ab}	0.007	0.07
Carcass wt., kg	88.13 ^b	88.24 ^b	88.13 ^b	88.13 ^b	90.57 ^a	89.43 ^{ab}	0.51	0.006
Loin depth, mm	55.73 ^c	55.19 ^c	55.96 ^{bc}	56.64 ^{abc}	58.12 ^a	57.51 ^{ab}	0.58	0.008

Key Words: copper, organic trace mineral, swine

143 (Invited ASAS Animal Science Young Scholar) Benefits of yeast mannan oligosaccharides in diets for animals: Immune function and disease resistance. T. M. Che* and J. E. Pettigrew, *University of Illinois, Department of Animal Sciences, Urbana.*

Different products extracted from the yeast cell wall may have diverse immune-related properties because each fraction differs in proportions of functional carbohydrates. This paper focuses on the effect of mannan oligosaccharides (MOS, Bio-Mos, Alltech Inc.) on immune function and disease resistance and describes immunomodulatory effects that may confer practical benefits. In innate immunity, MOS has been shown to enhance phagocytosis by rat phagocytes and to directly activate porcine alveolar macrophages (AMØ) to secrete inflammatory mediators. Further, dietary MOS increases expression of key inflammatory mediators involving pathogen detection, antigen presentation, and immune regulation in leukocytes of pigs. These changes may provide protection through increasing recognition and destruction of invading pathogens. The influence of MOS on adaptive immunity has been also investigated. Feeding MOS to animals increases the immunoglobulin levels in plasma, bile, and colostrum. When challenged with rotavirus, MOS-fed cows have increased transfer of rotavirus-specific antibody to calves. These results suggest that MOS heightens passive immunity. Recent studies revealed that MOS can modulate the immune responses to different stimulants. When fed to pigs or applied in vitro, MOS alleviates the inflammatory response of AMØ by reducing TNF- α and increasing IL-10. In pullets injected with phytohemagglutinin, dietary MOS reduces the intensity of the wattle hypersensitivity reaction. Immunomodulatory functions of MOS have been demonstrated in a porcine reproductive and respiratory syndrome virus (PRRSV) challenge study. Dietary MOS is associated with rapidly increased numbers of leukocytes in PRRSV-infected pigs. Additionally, the down-regulation of inflammation-related gene expression in leukocytes of PRRSV-infected pigs fed MOS may explain why fever was reduced in those pigs by d 7 postinfection. Taken together, immunomodulation by dietary MOS provides a novel prospect for improving animal health and production, but more research is still needed.

Key Words: disease resistance, immunomodulation, MOS

144 Phosphorus and energy digestibility in enzyme treated soybean meal. K. P. Goebel* and H. H. Stein, *University of Illinois, Urbana.*

Two experiments were conducted to measure P and energy digestibility in soybean meal (SBM) that had been enzyme treated to remove antigens in the meals. The apparent total tract digestibility (ATTD) of P was measured in Exp. 1 in conventional SBM (SBM-CV) and in 2 enzyme treated SBM (HP-310 and HP-340; Hamlet Protein, Horsens, Denmark). During production, HP-310 had been treated with an enzyme mixture containing no phytase while HP-340 was treated with an enzyme mixture that contained microbial phytase. Three diets containing SBM-CV, HP-310, and HP-340 as the only source of P were formulated. Three additional diets were formulated by adding 500 units of microbial phytase (Optiphos 2000; Enzyvia, Sheridan, IN) to each of the original diets. Thirty-six barrows (BW: 21.9 kg) were placed in metabolism cages and randomly allotted to the 6 diets. Pigs were fed experimental diets for 14 d and feces were collected during the final 5 d. The ATTD of P in all SBM was greater ($P \leq 0.05$) as phytase was included in the diet (79.5 vs. 65.5, 77.7 vs. 59.8, and 87.7 vs. 83.8% for SBM-CV, HP 310, and HP 340, respectively). The ATTD of P in HP-340 was greater ($P \leq 0.05$) than in the other 2 meals. In Exp. 2, the DE and ME in corn, SBM-CV and in 2 sources of enzyme treated SBM (HP-200 and HP-300) were measured using 28 barrows (BW: 16.8 kg). A corn-diet (96.45% corn) and 3 diets containing corn and each source of SBM were formulated. Vitamins and minerals were included in all diets. Pigs were placed in metabolism cages and randomly allotted to the 4 diets. The experiment lasted 14 d and feces were collected during the last 5 d. The DE in SBM-CV, HP-200, and HP-300 was 4,347, 4,333, and 4,316 kcal/kg DM, respectively. These values were not different, but they were greater ($P \leq 0.05$) than the DE in corn (3,891 kcal/kg DM). The ME was 3,980, 3,926, 3,914, and 3,780 kcal/kg DM in SBM-CV, HP-200, HP-300, and corn, respectively. These values were not different. It is concluded that enzyme treatment of SBM to remove antigens does not change the digestibility of P or energy in the meals, but if microbial phytase is included in the enzyme treatment, P digestibility is increased.

Key Words: digestibility, pigs, soybean meal

145 Energy concentration and phosphorus digestibility in yeast products, fish meal, and soybean meal fed to growing pigs. B. G. Kim* and H. H. Stein, *University of Illinois, Urbana.*

Two experiments were conducted to measure DE and ME and the standardized total tract digestibility (STTD) of P in 2 novel yeast products (Y1 and Y2), and in brewers yeast (BY), fish meal (FM), and soybean meal (SBM) fed to growing pigs. The concentration of DM, GE, and P was 94.8%, 5,103 kcal/kg and 1.07% in Y1; 94.4%, 4,926 kcal/kg, and 2.01% in Y2; 93.6%, 4,524 kcal/kg, and 1.40% in BY; 91.4%, 4,461 kcal/kg, and 3.26% in FM; and 87.7%, 4,136 kcal/kg, and 0.70% in SBM. The DE and ME in each of the ingredients were measured using 42 growing barrows (28.9 ± 1.28 kg BW). A corn-based basal diet and 5 diets containing corn and 24 to 40% of each

test ingredient were formulated. The total collection method was used to collect feces and urine, and the difference procedure was used to calculate values for DE and ME in each ingredient. The concentrations of DE in corn, Y1, Y2, BY, FM, and SBM were 4,004, 4,344, 4,537, 4,290, 4,544, and 4,362 kcal/kg DM (SEM = 57), respectively, and the ME values were 3,879, 3,952, 4,255, 3,771, 4,224, and 4,007 kcal/kg DM (SEM = 76). The ME in Y2 and FM was greater ($P < 0.05$) than the ME in corn and BY, whereas the ME in YA and SBM were not different from that of any of the other ingredients. The STTD of P in the 5 ingredients was determined using 42 barrows (28.3 ± 7.21 kg BW) that were placed in metabolism cages. Five diets were formulated to contain each test ingredient as the sole source of P and a P-free diet was used to estimate the basal endogenous loss of P. Fecal materials were collected for 5 d based on the marker to marker principle after a 5-d adaptation period. The STTD of P in BY (85.2%) was greater ($P < 0.05$) than the STTD of P in all the other ingredients except Y2 (75.7%). The STTD of P in Y1 (73.9%) was not different from the STTD of P in YB and FM (67.3%), but greater ($P < 0.05$) than the STTD of P in SBM (56.7%). In conclusion, the 2 novel sources of yeast contain a similar or greater concentration of energy than BY, corn, FM, and SBM, and the STTD of P in the 2 products is not different from the STTD of P in FM.

Key Words: digestibility, pigs, yeast

146 Effects of porcine circovirus type 2 (PCV2) vaccine and increasing standardized ileal digestible lysine:calorie ratio on growth performance of growing and finishing pigs. N. W. Shelton*¹, M. D. Tokach¹, S. S. Dritz¹, R. D. Goodband¹, J. L. Nelssen¹, J. M. DeRouchey¹, and J. L. Usry², ¹*Kansas State University, Manhattan*, ²*Ajinomoto Heartland Inc., Chicago, IL.*

Four experiments were conducted to determine the effect of PCV2 vaccination on the lysine requirement of growing and finishing pigs (PIC 1050 × 337). Experiments 1 and 2 evaluated 38 to 65 kg gilts and barrows, respectively, and Exp. 3 and 4 evaluated 100 to 120 kg gilts and barrows, respectively. Treatments were arranged in 2 × 4 factorials with 2 PCV2 treatments (vaccinates and non-vaccinates) and 4 standardized ileal digestible (SID) lysine:ME ratios (2.24, 2.61, 2.99, and 3.36 g/Mcal in Exp. 1 and 2 and 1.49, 1.86, 2.23, and 2.61 g/Mcal in Exp. 3 and 4). There were 5 pens/ treatment with 18 to 27 pigs/pen. No PCV2 vaccination × SID lysine:ME ratio interactions were observed ($P > 0.17$) in any of the 4 studies. In Exp. 1 and 2, PCV2 vaccinates had increased ($P < 0.001$) ADG compared with non-vaccinates. In Exp. 1, ADG and G:F improved (quadratic; $P < 0.04$) as the SID lysine:ME ratio increased. In Exp. 2, increasing the SID lysine:ME ratio improved (linear; $P < 0.001$) G:F. In Exp. 3, increasing the SID lysine:ME ratio increased (quadratic; $P < 0.05$) ADG and G:F. In Exp. 4, ADG increased (linear; $P < 0.001$) and G:F improved (quadratic; $P < 0.03$) as the SID lysine:ME ratio increased. Although PCV2 vaccination improved performance in Exp. 1 and 2, it did not increase the lysine requirement for growing and finishing barrows and gilts.

Table 1.

SID Lys:ME, g/Mcal	2.24	2.61	2.99	3.36	SE	Non-vaccinates	Vaccinates	SE
Exp. 1 (38-60 kg gilts)								
ADG, kg	0.75	0.80	0.82	0.79	0.01	0.73	0.84	0.01
G:F	0.43	0.46	0.48	0.47	0.008	0.46	0.47	0.006
Exp. 2 (39-65 kg barrows)								
ADG, kg	0.87	0.86	0.90	0.91	0.02	0.83	0.94	0.02
G:F	0.42	0.43	0.46	0.47	0.007	0.44	0.45	0.005
SID Lys:ME, g/Mcal	1.49	1.86	2.23	2.61				
Exp. 3 (102-125 kg gilts)								
ADG, kg	0.75	0.83	0.84	0.84	0.02	0.80	0.83	0.01
G:F	0.28	0.31	0.32	0.32	0.004	0.30	0.31	0.003
Exp. 4 (98-118 kg barrows)								
ADG, kg	0.89	0.94	0.96	1.02	0.01	0.97	0.94	0.01
G:F	0.30	0.30	0.30	0.33	0.006	0.31	0.31	0.008

Key Words: growing pig, lysine, porcine circovirus

147 Lysine requirement for finishing barrows fed ractopamine.

J. W. Bundy*, P. S. Miller, R. Moreno, T. E. Burkey, E. E. Hinkle, and H. Tran, *University of Nebraska, Lincoln*.

A total of 36 (Danbred × NE whileline) barrows was used during the final 4 wk of gain for the finishing phase (80 to 120 kg) to determine the total Lys (tLys) requirement of barrows fed ractopamine. Pigs were individually penned in an environmentally-controlled room. Pens were allotted to 1 of 6 dietary treatments in a completely randomized design. The 6 dietary treatments included: a control diet formulated to contain 0.7% tLys with no ractopamine; and 5 diets with 10 ppm ractopamine formulated to contain 0.5, 0.7, 0.9, 1.1 and 1.3% tLys, respectively. All diets were corn-soybean meal based with supplemented crystalline AA. Other AA, except Lys, were formulated at concentrations of at least + 10% of the true ileal digestible AA to Lys ratios (NRC, 1998). Increased Lys concentration was achieved by increasing soybean meal and Biolys inclusions. The addition of Biolys was formulated to provide 12.9% of the tLys concentration in all 6 diets. Treatment did not affect ($P > 0.10$) ADFI. There was no difference ($P > 0.10$) in BF or LM gain. Ractopamine tended to increase ($P = 0.08$) ADG for pigs fed 0.7% tLys (1.12 kg vs 1.28 kg; 0 vs 10 ppm ractopamine, respectively). Increasing Lys concentration of ractopamine diets increased ($P < 0.05$) ADG. Values for ADG ranged from 1.00 kg to 1.41 kg for pigs fed 0.5% and 0.9% tLys, respectively. Subsequently, G:F increased ($P < 0.05$) for pigs fed ractopamine and increased Lys. Values of G:F ranged from 0.29 to 0.42 for pigs fed 0.5 and 1.3% tLys, respectively. Non-linear, broken line, regression was used in order to determine the tLys concentration needed to maximize ADG or G:F for individually-penned barrows fed ractopamine. Regression analysis results indicate that 0.76% tLys (25.5 g/d) is needed to obtain maximum ADG. A tLys concentration of 0.77% (25.8 g/d) is needed in order to obtain maximum G:F. These results suggest that dietary Lys concentration affects growth rate and feed efficiency of barrows fed ractopamine.

Key Words: lysine, pigs, ractopamine

148 Effect of environment on the tryptophan:lysine ratio in nursery pigs. J. W. Frank*¹, C. L. Bradley¹, B. E. Bass¹, C. V. Maxwell¹, R. D. Boyd², and J. L. Usry³, ¹*University of Arkansas, Fayetteville*, ²*The Hanor Company Inc., Franklin, KY*, ³*Ajinomoto Heartland LLC, Chicago, IL*.

A total of 432 weaned pigs (GPK35 × PIC 380; 21 d of age; 4.3 kg BW) were housed in one of two environments: A conventional nursery located on the University of Arkansas sow farm (CONV) or an off-site nursery isolated from other pigs (OFF) in order to evaluate the effect of environment on Trp:Lys in nursery pigs. The CONV nursery was cleaned but not disinfected prior to the study. The OFF nursery was cleaned and disinfected. All pigs were housed 6/pen (6 replicates/treatment) and fed a common diet for 5 d prior to the start of the experimental period. During the experimental period (d 6 – 20; 4.9 kg BW), pigs were fed 1 of 6 diets: a positive control diet (1.3% TID Lys, 20.0% TID Trp:Lys), or a titration diet (1.2% TID Lys) with TID Trp:Lys of 14.8, 17.4, 20.0, 22.6, and 25.2%. All pigs were fed a common diet from d 21 – 42. Pigs in the OFF nursery had greater ADG, ADFI, and G:F than pigs in the CONV nursery throughout the experiment ($P < 0.001$). Although there were no statistical differences for the main effect of diet or environment by diet interactions during the experimental period, the growth performance responses to the titration diets in the two environments differed. Orthogonal contrasts of the titration treatments indicate that pigs housed in the OFF nursery had quadratic increases in ADG (244, 303, 329, 306, and 265 g/d; $P = 0.004$), ADFI (378, 458, 458, 444, and 393 g/d; $P = 0.005$) and G/F (0.628, 0.656, 0.698, 0.687, and 0.673; $P = 0.07$) as TID Trp:Lys increased from 14.8 to 25.2% during the experimental period. In the CONV nursery, there were no changes in ADG (186, 188, 193, 219, and 197 g/d) or G/F (0.551, 0.539, 0.522, 0.545, and 0.516) while there was a linear increase in ADFI (335, 344, 361, 382, and 381 g/d; $P = 0.06$) as TID Trp:Lys increased. In conclusion, there was a quadratic increase in the growth rate of pigs housed in the clean, high-health status environment in response to increasing Trp:Lys. Growth rate of the pigs housed in the dirty, low-health status environment did not respond to increasing Trp:Lys.

Key Words: pigs, tryptophan, environment

149 Determination of SID Trp:Lys requirement in grow-finish pig fed diets containing 30% DDGS. R. B. Hinson*¹, L. Ma¹, G. D. Gerlemann¹, G. L. Allee¹, J. D. Less², D. D. Hall³, H. Yang³, and D. Holzgraefe³, ¹*University of Missouri, Columbia*, ²*ADM Specialty Feed Ingredients, Decatur, IL*, ³*ADM Alliance Nutrition, Quincy, IL*.

Three experiments were conducted to determine the optimum SID Trp:Lys ratio in 27-45, 67-85, and 96-117 kg pigs consuming 30% DDGS diets. Each experiment utilized the same group of pigs (PIC 327 × C22 barrows and gilts) that were offered a nutrient adequate diet for at least two wks in between experiments. Pigs were housed in a commercial wean-finish facility with 20-24 pigs/pen. Dietary treatments within each experiment included a corn-sbm diet (SID Trp:Lys = 16) and corn-sbm-30% DDGS diets with SID Trp:Lys ratios of 12, 14, 16, 18, and 20. SID Trp:Lys ratios were obtained by the addition of crystalline L-Trp to the diet. Diets from 96-117 kg diets contained 5 ppm Paylean. From 27-45 kg, a linear ($P < 0.001$) and quadratic ($P < 0.006$) ADG response was observed with increasing SID Trp:Lys ratio, with an ADG plateau at 0.83 kg/d at a SID Trp:Lys ratio of 16. There were no differences in F:G ($P > 0.05$) between the treatments. Broken line and quadratic regression estimation suggests a minimum SID Trp:Lys

ratio of 16. From 67-85 kg, ADG was linearly increased ($P < 0.01$) with increasing SID Trp:Lys ratios and ADG being optimized at 0.82 kg/d with an SID Trp:Lys ratio of 12. Feed efficiency was linearly improved ($P < 0.004$) with increasing SID Trp:Lys ratios. Broken line estimation suggests a minimum SID Trp:Lys ratio of 13.9 for both ADG and F:G. From 96-117 kg, ADG was linearly increased ($P < 0.033$) with ADG being optimized at 1.01 kg/d with an SID Trp:Lys ratio of 16. These data would suggest that SID Trp:Lys ratios of 16 are adequate for G-F pigs from 27-117 kg when DDGS is included at 30% of the diet.

Key Words: pigs, dried distillers grains w/ solubles, tryptophan

150 Determination of standardized ileal digestible tryptophan requirements of growing-finishing pigs fed diets containing high protein distillers dried grains. L. Ma*, Z. P. Zhu, R. B. Hinson, and G. L. Allee, *University of Missouri, Columbia.*

Three experiments were conducted to estimate the optimum standardized ileal digestible (SID) tryptophan requirements of growing-finishing barrows fed diets containing high protein distillers dried grains (HPDDG). The SID lysine levels of the basal diet in these experiments were 0.95%, 0.81%, and 0.73%, respectively. One-slope straight broken-line and quadratic broken-line regression analysis was conducted to determine the optimal SID tryptophan requirement. In Exp. 1, 56 barrows (initial BW of 45.9 kg) were fed a Corn-SBM control diet and six titration diets (Corn-23.7% HPDDG) containing SID Trp of 0.08, 0.10, 0.13, 0.15, 0.18, and 0.20% for 17 days. ADG ($P < 0.01$) and G:F ($P < 0.02$) were linearly improved with increasing levels of SID Trp. Quadratic responses ($P < 0.05$) were also observed in ADG. Linear and quadratic broken-line regression analysis suggests an optimum SID Trp of 0.14%. In Exp. 2, 48 barrows (initial BW of 70.0 kg) were fed a Corn-SBM control diet and five titration diets (Corn-SBM-19.3% HPDDG) containing SID Trp of 0.08, 0.10, 0.12, 0.14, and 0.16% for 21 days. There were significant differences ($P < 0.01$) in ADG and ADFI among treatments. ADG ($P < 0.02$) was linearly improved with increasing levels of SID Trp. Quadratic responses ($P < 0.01$) were observed in ADG and ADFI with increasing levels of SID Trp. Linear and quadratic broken-line regression analysis suggests an optimum SID Trp of 0.11%. In Exp. 3, 48 barrows (initial BW of 95.0 kg) were fed a Corn-SBM control diet and five titration diets (Corn-16.7% HPDDG) containing SID Trp of 0.07, 0.10, 0.12, 0.15, and 0.17% for 18 days. ADG increased in both linear ($P < 0.05$) and quadratic ($P < 0.02$) pattern, as the SID Trp levels increased. Linear and quadratic broken-line regression analysis suggests an optimum SID Trp of 0.11%. In summary, the results of these experiments indicate the optimum SID Tryptophan requirements are 0.14, 0.11, and 0.11% for pigs from 45- to 64- kg, 70- to 93- kg, and 95- to 115- kg fed diets containing high level of HPDDG.

Key Words: tryptophan, requirement, high protein distillers dried grains

151 Determination of SID Trp:Lys ratio requirement of 11- to 22-kg pigs fed diets containing 30% DDGS. L. Ma*¹, Z. P. Zhu¹, R. B. Hinson¹, G. L. Allee¹, J. D. Less², D. D. Hall³, H. Yang³, and D. P. Holzgraefer³, ¹University of Missouri, Columbia, ²ADM Specialty Feed Ingredients, Decatur, IL, ³ADM Alliance Nutrition, Quincy, IL.

A 21-day experiment was conducted to estimate the optimal standardized ileal digestible tryptophan to lysine ratio requirement of 11- to 22-kg

barrows fed diets containing 30% distillers dried grains with solubles (DDGS). Barrows (108 hd; PIC337 × C22; initial BW=11.1 kg) were blocked by body weight and allotted to one of six dietary treatments by randomized complete block design with nine replicate pens with two pigs per pen. All diets, including a corn-SBM positive control diet and five titration diets, were formulated at SID lysine of 1.20% and titration diets contained SID Trp:Lys ratios of 12.0, 14.0, 16.0, 18.0, and 20.0 obtained by the addition of crystalline L-Tryptophan. The corn-SBM positive control diet was fed to make sure pig performance was normal. Body weight gain and feed disappearance were recorded to calculate ADG, ADFI, and G:F. There were significant differences ($P < 0.01$) in final BW, ADG, ADFI, and G:F among titration treatments. ADG (0.45, 0.52, 0.55, 0.54, and 0.59 kg/d; SE = 0.019), ADFI (1.43, 1.56, 1.63, 1.58, and 1.74 kg/d SE = 0.06) and G:F (0.62, 0.66, 0.67, 0.68, and 0.68; SE = 0.013) were linearly improved ($P < 0.001$) as SID Trp:Lys ratio increased. G:F tended to respond quadratically ($P < 0.06$) with increasing SID Trp:Lys ratios. However, pigs fed the corn-SBM control diet tended to have greater ADG (0.62 kg/d) than pigs fed the 30% DDGS diets. One-slope straight broken-line analysis estimated the minimal SID Trp:Lys ratio to be 15.1 for ADG, and 14.9 for G:F. Eight pigs within each treatment were bled at day 19 to determine serum urea nitrogen (SUN). No significant difference ($P > 0.29$) in SUN (7.91, 6.70, 4.91, 5.78, and 6.44 mg/dL SE = 0.98) was observed across the five titration treatments. In summary, the SID Trp:Lys ratio for nursery pigs from 11 to 22 kg fed diets containing 30% DDGS is 15.0.

Key Words: tryptophan, ratio, distillers dried grains with solubles

152 (National Pork Board Research Award) Effect of genotype on heat production and the net energy (NE) value of a corn-soybean meal-based diet. E. Kiarie* and C. M Nyachoti, *University of Manitoba, Winnipeg, MB, Canada.*

The NE takes into account the metabolic utilization of energy and has been proposed as a superior system for characterizing the energy value of feeds. In growing pigs, the inefficiency of ME utilization for NE (or the heat increment) is dependent on many factors among them the genotype, which implies that, published prediction equations, may not apply across all genotypes. We conducted a study to investigate, the effect of two genotypes (Yorkshire + Hampshire × Duroc; YHxD and Large white × Landrace; LxL) on heat production and NE value of corn soybean meal-based diet fed to growing pigs. The diet met or exceeded the nutrient specifications of 20-50 kg BW pigs according to NRC (1998). A total of sixteen barrows were used, 8 of each genotype (initial BW of 20.1±1.1 and 19.0±0.9 kg for YHxD and LxL, respectively). Pigs were initially fed for 13 d at 550 kcal ME/kg BW^{0.60}/d (high ME intake) for determination of DE and ME in metabolism crates. Thereafter, heat production (HP) was measured using indirect calorimeter at either high ME or 330 kcal ME /kg BW^{0.60}/d (low ME) intake to estimate fasting HP (FHP) by regression. Pigs were allowed 3-d adaptation period at low ME intake before measurement of HP. Irrespective of the genotype, a reduction of ME intake resulted in a decrease ($P < 0.0001$) of HP (352 for high ME vs. 292 kcal/ kg BW^{0.60}/d for low ME). Pigs of LxL tended ($P = 0.07$) to have higher HP than those of YHxD and their estimated FHP was 175 and 103 kcal/ kg BW^{0.60}/d, respectively. A higher ($P = 0.015$) NE of the diet was observed for LxL pigs compared with YHxD pigs (2,633 vs. 2,307 kcal/kg DMI). Pigs of LxL showed higher efficiency of utilization of DE (70 vs. 60%) and ME (72 vs. 61%) for NE than pigs of YHxD. The NE value of the corn-soybean meal was 96% (LxL) and 81% (YHxD) of the predicted NE from published equations (Noblet

et al., 1994). In conclusion, corn-soybean meal fed at equal amount resulted in different HP and NE value in two genotypes.

Key Words: heat production, net energy, pigs

153 Practical method for estimating productive energy (NE) of wheat middlings for growing pigs. R.D. Boyd¹, C.E. Zier-Rush*¹, and C.E. Fralick², ¹The Hanor Company, Franklin, KY, ²Swine-Tek Research, Van Wert, OH.

This study was conducted to verify the net energy estimate (NE), for a chemically defined source of middlings. We describe a practical assay (26 d) that uses a simple corn-soybean meal diet (C-S) as a reference standard and G:F ratio as the criterion for productive energy use. Middlings were exchanged in increments for corn, lysine and threonine. Soybean meal and fat content were held constant (17.55, 0.75%) across diets. Corn served as the energy standard (2.646 mcals/kg); middlings was estimated through algorithm and trial to be 2.325 (88% DM basis). Middlings were obtained from a chemically defined source having 22.7% starch (CP, 16.5; Fat, 5.5; CF, 9.0; NDF, 34.0; Ash, 4.8). A total of 451 PIC pigs (79.5 ± 2 kg) were allotted by weight and gender to one of 6 diet sets (48 pens). The C-S diet was allocated to two sets of 8 pens each to establish a reliable reference. Four middlings diets were formed by summit blend to contain 4.5, 9.0, 13.5 or 18.0% middlings. Diet NE for 0 (C-S), 4.5, 9.0, 13.5, 18.0 formulas declined slightly: 2.480, 2.467, 2.454, 2.440, 2.427 mcals/kg. Diets were fed ad libitum and in meal form. Pigs averaged 109.2 kg (± 0.6) at the conclusion of test ($P > 0.10$). Diet did not affect feed intake (3.33 kg/d ± 0.05), growth rate (1.15 kg/d, ± 0.02) or G:F (0.344 ± 0.003). G:F ratio for the reference diet was 0.345 (0.345, 0.346); middlings treatments averaged 0.346, 0.348, 0.342 and 0.337 for respective level (4.5, 9.0, 13.5, 18.0%). Regression analysis suggests that slope of the middlings response was not different from zero ($P > 0.15$), and that G:F response to middlings level is described by: $-0.005 \times \text{Middlings \%} + 0.348$ (R^2 , 0.543). The slight numerical bias for the middlings G:F slope is due largely to the “drift” in diet NE content as middlings were exchanged for corn and amino acids (1.20%). We conclude that the NE estimate for this middlings source is reliable (2.325 mcals/kg, 88% DM), and that it has approximately 87.9% the productive energy of corn. This assay method is challenging with respect to control of diet variables, but it is a practical means of estimating NE for practice, at different stages of growth and with sufficient numbers to be meaningful.

Key Words: pigs, wheat middlings, net energy

154 Comparative digestibility of energy and nutrients in fibrous feed ingredients by Meishan and Yorkshire pigs. P. E. Urriola* and H. H. Stein, University of Illinois, Urbana.

The objective was to measure the apparent ileal (AID) and the apparent total tract digestibility (ATTD) of nutrients by Meishan and Yorkshire pigs fed 5 diets with different concentrations of total dietary fiber (TDF) and insoluble dietary fiber (IDF). The control diet was based on corn and soybean meal and contained 5 g/kg of titanium dioxide. Three additional

diets were formulated by replacing 30% of the control diet with 30% of distillers dried grains with solubles (DDGS; TDF: 31.5%, IDF: 31.0%), soybean hulls (SBH; TDF: 57.2%, IDF: 51.0%), or sugar beet pulp (SBP; TDF: 67.0%, IDF: 61.6%). The last diet was formulated by replacing 15% of the control diet with 15% of pectin (TDF: 45.0%, IDF: 0.0%). Five Meishan (82.5 kg; 5 mo old), 5 light Yorkshires (90.0 kg; 4 mo old), and 5 heavy Yorkshires pigs (118.7 kg; 5 mo old) were fitted with a T-cannula in the distal ileum. Pigs within each group were randomly allotted to a 5 × 5 Latin square design with 5 diets and 5 periods. Fecal samples were collected on d 12 and ileal digesta were collected on d 13 and 14 of each period. The AID and ATTD of GE and nutrients in each ingredient were calculated using the substitution procedure. When fed the control diet, Meishan pigs, had a tendency ($P \leq 0.10$) for greater AID of GE and CP (78.4 and 80.2%) than light (76.8 and 78.8%), and heavy Yorkshire pigs (75.5 and 76.7%). and had a greater ($P \leq 0.05$) ATTD of DM, GE, and carbohydrates (89.2, 89.4, 95.5%; respectively) than light (86.5, 86.3, and 92.3) and heavy Yorkshire pigs (87.0, 86.5, and 92.9%). The ATTD of DM, GE, CP, carbohydrates, and TDF in DDGS (81.3, 81.4, 85.5, 91.4, and 70.0%) were greater ($P \leq 0.01$) in Meishan pigs than in light Yorkshire (58.8, 60.9, 77.6, 85.3, and 47.8%) and heavy Yorkshire pigs (67.3, 69.4, 80.7, 86.4, and 60.0%). There were no differences among the 3 groups of pigs in the ATTD of nutrients in SH, SBP, and pectin. In conclusion, Meishan pigs have a greater ATTD of DM and GE in corn-soybean meal diets and in DDGS than Yorkshire pigs, but not in SH, SBP, and pectin.

Key Words: dietary fiber, breed, digestibility

155 Estimating the metabolizable energy contribution of Albac (zinc bacitracin) in growing and finishing swine diets. D.A. Nelson*, Alpharma Animal Health, Bridgewater, NJ.

A total of 840 pigs (5 treatments, 8 repetitions/treatment, 21 pigs/pen) were used to evaluate the energy contribution of Albac in growing-finishing swine diets. A 6 phase dietary grow-finish program was utilized. All diets were corn-SBM based and a constant available lysine/calorie ratio was maintained. Dietary treatments were imposed from approximately 28.0 to 123.0 kg body weight. Four treatments consisted of diets containing 1.0, 2.0, 3.0, and 4.0 % added fat (animal/vegetable blend). A fifth treatment contained 1.0% added fat and 27.5 ppm Albac. Standard curves were generated from the first four treatments by regressing ADG and gain to feed on level of added dietary fat. Overall ADG, gain to feed and final BW increased linearly, and ADFI declined linearly as the level of dietary fat increased in the diets, validating the model used in this experiment to estimate the ME contribution of Albac (Table 1). Cost/kg gain, mortality and removals, carcass backfat, and lean yield were not different ($P > 0.10$) as level of added fat increased in the diet. Pigs fed the 1.0% added fat + Albac diet had a higher ($P < 0.05$) ADG, a heavier ($P < 0.05$) final BW, and better ($P < 0.10$) feed efficiency than pigs fed the 1.0% added fat diet (Table 1). Using overall ADG as the response variable, the inclusion of 27.5 ppm Albac gave similar performance as 2.46% added fat or 123.2 added kcal ME/kg of complete feed ($R^2=0.92$). Using overall gain to feed as the response variable, the inclusion of 27.5 ppm Albac gave similar performance as 1.29% added fat or 64.4 added kcal ME/kg of complete feed ($R^2=0.94$).

Table 1. Overall pig performance with increasing dietary fat and 27.5 ppm Albac

Response	+1.0% fat	+2.0% fat	+3.0% fat	+4.0% fat	+1.0% fat + 27.5 ppm Albac	SEM
Initial wt, kg	28.0	27.6	28.1	27.8	28.1	0.37
ADG, kg/d ^a	0.89	0.89	0.91	0.92	0.91*	0.01
ADFI, kg/d ^b	2.43	2.39	2.41	2.33	2.43	0.03
Gain to feed, kg/kg ^a	0.367	0.374	0.380	0.395	0.377*	0.01
Final BW, kg ^b	121.5	123.2	122.8	124.1	124.3*	0.78

^aLinear effect of fat, $P < 0.01$; ^bLinear effect of fat, $P < 0.05$; *+1.0% fat+27.5 ppm Albac vs +1.0% fat, $P < 0.10$.

Key Words: swine, zinc bacitracin, ME

156 (Invited ASAS Animal Science Young Scholar) Viscosity and fermentability of purified non-starch polysaccharides (NSP) affect kinetics of digestion and hormone secretion in ileal-cannulated and porto-arterial catheterized pigs. S. Hooda^{*1}, B. U. Metzler-Zebeli¹, J. J. Matte², T. Vasanthan¹, and R. T. Zijlstra¹, ¹University of Alberta, Edmonton, AB, Canada, ²Agriculture and Agri-Food Canada, Sherbrooke, QC, Canada.

An understanding of physico-chemical characteristics of NSP and its effects on digestive physiology may enhance successful incorporation of fibrous feedstuffs in swine diets. Soluble NSP increase digesta viscosity, modify digesta passage rate and nutrient absorption whereas insoluble NSP increase digesta bulk and passage rate and thereby reduce nutrient digestion. We hypothesized that viscosity and fermentability of purified NSP have differential effects on kinetics of nutrient digestion, absorption and secretion of insulin and incretin. Thus, ileal-cannulated grower pigs were fed semi-purified [cornstarch, casein] diets supplemented with 5% purified NSP sources in a 2 (low, high viscous; V) × 2 (low, high fermentable; F) factorial arrangement using: low V, low F cellulose (CEL), high V, low F carboxymethylcellulose (CMC), low V, high F oat β-glucan (LG), and high V, high F oat β-glucan (HG). In cannulated pigs, CMC, LG and HG induced high ileal ($P < 0.001$) digesta viscosity coinciding with high ($P < 0.05$) nutrient digestibility; in contrast, CEL had the lowest ($P < 0.001$) viscosity and nutrient digestibility. The CEL, LG and HG increased ($P < 0.05$) fecal SCFA and thus colonic fermentation. Reduced nutrient digestibility was related stronger to fermentation than viscosity ($R^2 = 0.72-0.85$ vs. $0.36-0.45$). In catheterized pigs, high V and F oat β-glucan reduced ($P < 0.05$) net glucose absorption and insulin secretion via modification of incretin (GLP-1 and GIP) release ($P < 0.05$). Portal insulin and incretin were related strongly ($R^2=0.61-0.88$) with net glucose absorption, indicating the crucial role of glucose for release of pancreatic and intestinal hormones. In conclusion, viscosity of NSP has less negative effects on nutrient digestibility than fermentation; however, nutrient absorption and hormones secretion appear more affected by viscosity.

Key Words: NSP, viscosity, fermentability

157 Energy concentration and phosphorus digestibility in milk products fed to weanling pigs. B. G. Kim, J. W. Lee, and H. H. Stein^{*}, University of Illinois, Urbana.

Two experiments were conducted to measure DE, ME, and apparent (ATTD) and standardized total tract digestibility (STTD) of P in 3 milk products (i.e., whey powder, Perlac 850, and Variolac 960) fed to weanling pigs. Whey powder contains 95.8% DM, 3,647 kcal GE/kg, 66.0% lactose, 13.0% CP, and 0.63% P; Perlac 850 contains 97.7% DM, 3,426 kcal GE/kg, 76.1% lactose, 4.3% CP, and 0.57% P, and Variolac 960 contains 98.4% DM, 3,657 kcal GE/kg, 88.9% lactose, 3.0% CP, and 0.10% P on an as-fed basis. Perlac 850 was produced by extracting most of the protein from whey powder, and Variolac 960 was produced by extracting both protein and ash from whey powder. Both Perlac 850 and Variolac 960 were produced by Arla Foods (Aarhus, Denmark). The DE and ME in the 3 milk products were measured using 32 barrows (9.2 ± 0.44 kg BW). A basal diet based on corn and soybean meal and 3 diets containing 70% of the basal diet and 30% of each milk product were prepared. Each diet was fed to 8 pigs that were housed individually in metabolism crates. The total collection method was used with 5-d adaptation and 5-d collection periods. The concentrations of DE in whey powder, Perlac 850, and Variolac 960 were 3,646, 3,253, and 3,683 kcal/kg DM (SEM = 76.4), respectively, and the ME values were 3,462, 3,081, and 3,593 kcal/kg DM (SEM = 79.9). The STTD of P in the milk products was determined using 32 barrows (11.0 ± 0.81 kg BW). Three diets containing 30% of each milk product as the sole source of P were prepared, and a P-free diet was used to estimate the basal endogenous loss of P. The ATTD of P in whey powder and Perlac 850 was greater ($P < 0.05$) than in Variolac 960 (84.3 and 86.1 vs. 55.9%; SEM = 2.08), but the STTD values of P were not different (91.2, 93.1, and 91.8% in whey powder, Perlac 850, and Variolac 960, respectively). The basal endogenous loss of P was 153 mg/kg DMI. In conclusion, Perlac 850 contains less energy than whey powder or Variolac 960, but the STTD of P in all 3 milk products is relatively high and not different among sources.

Key Words: milk products, digestibility, pigs

158 Effects of corn distillers dried grains with solubles (DDGS) on quality traits of pork. K. M. McClelland^{*1}, G. Rentfrow¹, G. L. Cromwell¹, M. D. Lindemann¹, and M. J. Azain², ¹University of Kentucky, Lexington, ²University of Georgia, Athens.

A study was conducted to evaluate the effects of high levels of DDGS on performance and pork quality. Sixty crossbred pigs (3 replications, 5 pigs/pen) were fed fortified corn-soybean meal diets containing 0, 15, 30 or 45% DDGS from 35 to 120 kg BW as part of a larger study (J. Anim. Sci. 87:E-Suppl. 3:81, 2009). DDGS did not influence ADG (1.05, 1.05, 1.02, 1.04 kg), but feed/gain increased linearly (2.68, 2.72, 2.74, 2.86; $P < 0.02$) with increasing DDGS level. Backfat and belly fat samples were obtained from all carcasses for fatty acid (FA) analysis and iodine values. Belly flex measures indicated less firm bellies (linear, $P < 0.03$) as DDGS levels increased (lateral flex: 10.3, 7.1, 6.0, 4.6 cm; vertical flex: 27.7, 29.2, 29.8, 30.8 cm). The PUFA in subcutaneous fat increased linearly (15, 18, 24, 27% of total FA; $P < 0.001$) as did iodine values (64, 69, 76, 80) with increasing DDGS in the diet. Bellies were pumped to target 12% brine retention, thermally processed, and sliced (9 slices/2.5 cm) at a commercial plant, and characteristics of fresh bacon slices were determined. Slices

were given a score of 0 to 6 with 0 representing no visible cracks or shattering in the fat and 6 representing a spider-web-like consistency of shattering. Shatter of bacon slices decreased (linear, $P < 0.001$) with increasing level of dietary DDGS (4.37, 4.10, 3.55, 3.54). TBARS determined on Bratwurst sausages increased linearly with DDGS level (d 7: 1.03, 0.95, 1.18, 1.38 mg/kg; $P < 0.03$). An 8-member trained panel evaluated fried bacon slices, sausage, and loin chops. Fried bacon distortion scores were unaffected by treatment (2.68, 2.46, 2.51, 2.56; higher score indicates more curling). DDGS level did not influence texture or off-flavors in bacon slices nor tenderness, juiciness, or off-flavors in loin chops. However, DDGS did influence texture (less mushy and more chewy; 8.46, 6.97, 7.38, 6.52; $P < 0.004$) and increased juiciness (6.70, 7.50, 7.38, 8.19; $P < 0.04$) in sausages. The results indicate that the softer carcasses associated with feeding DDGS did not negatively affect quality of fresh bacon slices nor eating quality of bacon, sausage, or loin chops.

Key Words: pigs, DDGS, pork quality

159 Attempts to improve belly firmness in finishing pigs fed a high level of DDGS. M. C. Ulery^{*1}, G. L. Cromwell¹, G. K. Rentfrow¹, M. D. Lindemann¹, and M. J. Azain², ¹University of Kentucky, Lexington, ²University of Georgia, Athens.

An experiment involving 168 pigs (6 reps of 3 or 5 pigs/pen) was conducted to determine if feeding a high level of DDGS followed by varying withdrawal periods before slaughter, or if adding a more saturated fat (tallow) to diets containing DDGS (to reduce the dietary U:S fatty acid [FA] ratio) would offset the softer bellies that occur when high levels of DDGS are fed. Treatments (Trt) were (1) a corn-soy diet or (2) a similar diet with 45% DDGS fed to term or removed during the final 2, 4, or 6 wk (Trt 3, 4, 5) followed by the corn-soy diet. Trt 6 and 7 were the same as 1 and 2 except 5% tallow was added. The DDGS analyzed 28% CP, 10% fat, and 0.73% lys. Three diet phases were fed from 38 to 122 kg BW. Diets for Trt 1-5 were formulated on a true ileal digestible (TID) lys basis with 0.83, 0.70, and 0.58% TID lys during the 3 phases. Adjustments were made in diets with fat to maintain the same TID lys:ME ratio as in diets without fat. ADG, but not feed/gain (F/G), was reduced by DDGS inclusion ($P < 0.05$) and ADG improved linearly ($P < 0.05$) with withdrawal time (1.01, 0.93, 0.96, 0.98, 0.98 kg; 2.78, 2.77, 2.82, 3.03, 2.88 for Trt 1-5). ADG increased with tallow addition to the DDGS diet, and F/G improved ($P < 0.01$) with tallow addition to both diets (1.00, 1.00 kg; 2.42, 2.45 for Trt 6 and 7). Backfat and belly fat were obtained from 3 pigs/pen for FA analysis. Flex measures indicated less firm bellies in pigs fed DDGS ($P < 0.01$). Belly firmness increased linearly ($P < 0.01$) with increased withdrawal time, but tallow addition had no positive effect on firmness (lateral flex: 15, 11, 12, 13, 15, 14, 11 cm; vertical flex: 32, 34, 33, 33, 31, 32, 34 cm, respectively). Saturated FA and MUFA in belly fat decreased and PUFA increased when DDGS was fed ($P < 0.01$), and these changes were moderated (linear, $P < 0.01$) with DDGS withdrawal time (e.g., linoleic acid: 12, 22, 18, 17, 15, 11, 21% of total FA). Iodine values followed similar trends (64, 78, 74, 71, 69, 67, 79). The results indicate that withdrawal of a high level of DDGS from the finishing diet for 4 to 6 wk restores carcass firmness, but addition of a harder fat such as tallow does not overcome softer bellies.

Key Words: pig, DDGS, firmness

160 (Invited ASAS Animal Science Young Scholar) Dietary fiber and distillers dried grains with solubles as modulators of pig health. V. Perez^{*} and J. Pettigrew, University of Illinois, Urbana.

The source of fiber in the diet can modify both microbiota and physical environment of the gut. The direction of those effects is mostly based on the solubility of the fiber and its capacity to be fermented. The soluble fraction of fiber (SOL-F) can be fermented very rapidly. It has been suggested that SOL-F benefits gut health because it promotes the growth of commensal bacteria, which inhibit the growth of pathogens; this concept is known as colonization resistance. Controversially, some disease-challenge studies have shown that inclusion of SOL-F in the diet exacerbates postweaning diarrhea; this negative effect has been related to a greater viscosity of the digesta. In addition, the same studies suggest that low-fiber diets based on rice and animal protein help to reduce postweaning diarrhea. It is not clear, however, whether the contribution from an unknown compound in rice called the rice factor is important or not in that effect. On the other side of the equation, insoluble fiber (INS-F) promotes several physiological effects that are considered to be beneficial for intestinal health, although those studies were conducted in healthy pigs. It is thought that dietary distillers dried grains with solubles (DDGS) may promote pig health. That may be possible because of its large concentration of INS-F, but it lacks of empirical evidence. In a series of disease-challenge studies, we have consistently observed that up to 20% DDGS in the diet does not prevent pigs from *E. coli* infection; however, DDGS appears to delay the shift from commensal to β -hemolytic coliforms in feces and speed the excretion of β -hemolytics. This observation was not followed by a reduction in clinical signs of the disease, but some histological responses suggest a faster recovery as well. The analysis of gut microbial populations suggested that dietary DDGS may promote a more stable and uniform microbiota. Furthermore, dietary supplementation with fiber from cellulose (INS-F), but not from pectin (SOL-F), expedited the recovery from postweaning colibacillosis diarrhea. The inclusion of DDGS or INS-F in the diet is a potential opportunity to promote pig health.

Key Words: DDGS, dietary fiber, postweaning colibacillosis

161 Effect of dried distillers grains with solubles (DDGS) withdrawal regimens on finishing pig performance and carcass traits. J. Y. Jacela^{*1}, J. M. Benz¹, S. S. Dritz¹, M. D. Tokach¹, J. M. DeRouchey¹, R. D. Goodband¹, J. L. Nelssen¹, and K. J. Prusa², ¹Kansas State University, Manhattan, ²Iowa State University, Ames.

A total of 962 pigs (BW = 39 kg) were used to study the effect of DDGS withdrawal regimens on growth performance and carcass traits. Pigs were randomly assigned to 1 of 6 treatments (6 pens/trt) balanced by BW within gender. Treatments were a corn-SBM diet without DDGS fed for 89 d (trt 1), or diets with 0, 15, or 30% DDGS at varying durations during the grow-finish stage (trt 2 to 6; Table 1). There were no treatment \times gender interactions ($P > 0.21$) for any criteria and no overall differences ($P > 0.35$) in growth performance among treatments. Final BW numerically decreased as duration of feeding DDGS increased ($P = 0.79$). Feeding DDGS, regardless of amount or duration, had no effect ($P > 0.39$) on carcass traits. Pigs fed DDGS had increased ($P < 0.01$) jowl fat iodine value (IV) compared with trt 1 pigs. When withdrawal duration increased (trt 6, 3, 2, and 1), jowl fat IV decreased (linear; $P < 0.01$). Rate of IV decrease in jowl fat was 0.08 and 0.34 g/100g each wk that DDGS was reduced

to 15 or 0%, respectively. Feed cost/pig was highest ($P < 0.05$) when 0% DDGS was fed or withdrawn 6 wk before marketing (trt 1 and 2) and lowest when DDGS was added in the diets until at least 3 wk before marketing (trt 3 to 6). However, the reduction in feed cost did not improve ($P > 0.57$) income over feed cost. In summary, DDGS reduction or withdrawal 3 or 6 wk before market did not affect growth performance or totally alleviate its negative effect on carcass fat IV.

Table 1.

Treatment:	DDGS, %						SEM
	1	2	3	4	5	6	
d 0 to 48:	0	30	30	30	30	30	
d 48 to 69:	0	0	30	15	30	30	
d 69 to 89:	0	0	0	15	15	30	
BW (d 0), kg	39.0	38.9	39.0	39.5	39.3	38.6	0.96
BW (d 89), kg	121.5	120.9	121.1	119.4	118.7	118.6	1.84
ADG, kg	0.925	0.927	0.920	0.900	0.900	0.907	0.0141
ADFI, kg	2.413	2.428	2.430	2.449	2.398	2.398	0.0436
G:F	0.452	0.497	0.432	0.451	0.512	0.488	0.0184
Yield, %	75.1	75.7	75.9	75.1	75.2	75.7	0.42
Jowl IV, g/100g	68.6	72.6	73.3	74.2	74.6	74.7	0.85
Feed cost, \$/ pig	44.81	43.45	42.65	42.46	41.56	40.99	0.755
IOFC, \$/pig	74.30	77.32	76.88	78.65	76.02	78.86	1.969

Key Words: carcass, DDGS, growth

162 Effects of distillers dried grains with solubles and lactose on growth performance of nursery pigs. H. Tran*, R. Moreno, J. W. Bundy, E. Hinkle, T. E. Burkey, and P. S. Miller, *University of Nebraska, Lincoln*.

A 4-wk feeding experiment was conducted to evaluate the effects of distillers dried grains with solubles (DDGS), lactose, and a combination of DDGS with lactose on growth performance of nursery pigs. Ninety six pigs (age, 23 ± 2 d; initial BW, 6.43 ± 0.05 kg) were randomly allotted into each of 16 pens by gender, ancestry, and weight (6 pigs/pen; 4 pens/treatment). In Phase 1 (wk 1 and 2), pigs were fed 1 of the 4 treatments: 1) control (no DDGS and lactose), 2) 15% DDGS, 3) 20% lactose, 4) 15% DDGS + 20% lactose. In Phase 2 (wk 3 and 4), all pigs were fed a common diet containing 15% DDGS and 10% lactose. Diets were formulated to contain 1.47 and 1.42% true ileal digestible Lys in Phase 1 and 2, respectively. There were no DDGS effects on ADG, ADFI, and G:F during Phase 1; however, pigs receiving DDGS compared to no DDGS in Phase 1 had greater ADG (576.2 vs. 534.6 g; $P = 0.05$) and ADFI (814.9 vs. 751.6 g; $P = 0.004$) during Phase 2. Compared to pigs that did not receive lactose in Phase 1, pigs receiving lactose had 21% greater ADG (214.7 vs. 177.2 g; $P = 0.01$), 12% greater G:F (0.741 vs. 0.660 g/g; $P = 0.01$), and a trend for increased ADFI (289.3 vs. 267.6 g; $P = 0.07$) during Phase 1, but decreased ADG (537.7 vs. 573.1 g; $P = 0.09$) during Phase 2. In conclusion, there was no interaction between DDGS and lactose in Phase 1, 2 or the overall experimental period; however, growth performance was maintained when lactose was incorporated in nursery diets containing DDGS.

Key Words: distillers dried grains with solubles, lactose, weaning pig

163 Development of equations to predict the metabolizable energy content of distillers dried grains with solubles (DDGS) samples from a wide variety of sources. O. F. Mendoza*, M. Ellis¹, A. M. Gaines², M. Kocher², T. Sauber³, and D. Jones³, ¹University of Illinois, Urbana, ²The Maschhoffs, Carlyle, IL, ³Pioneer Hi-Bred, Johnston, IA.

This study was carried out to develop regression equations to predict the ME content of DDGS samples from Midwestern ethanol plants. The ME content of 17 commercial DDGS samples, chosen to represent the variation in nutrient content currently available to the industry, was determined in a metabolism study. Barrows (17.0 ± 0.9 kg BW; $n = 18$) were fed a corn-based diet (89.5% corn supplemented with 8.0% sodium caseinate, 1.0% limestone, 0.65% dicalcium phosphate, and 0.85% minerals and vitamins) and diets with 50.4% of the corn replaced with each sample of DDGS. An incomplete block design (block = group of 18 crates) was used with the corn and DDGS diets being fed to 36 and 8 pigs, respectively over a 4-d adaptation period followed by a 3-d collection of feces and urine. Gross energy of diets, feces and urine were determined by bomb calorimetry. The energy values for the corn were $3,891 \pm 71.4$ kcal DE/kg DM and $3,804 \pm 75.0$ kcal ME/kg DM and the DE and ME of the DDGS samples were determined by the difference method. Chemical composition (CP, crude fat, crude fiber, ADF, NDF, ash, and starch) of each DDGS sample was analyzed by two commercial laboratories. Equations to predict ME content were developed using the stepwise selection method of the REG procedure of SAS. There was a large range between DDGS samples for GE (5,177 to 5,421 kcal/kg DM; SD 64.4), DE (3,322 to 3,797 kcal/kg DM; SEM 55.0; $P < 0.001$), and ME (3,008 to 3,478 kcal/kg DM; SEM 66.6; $P < 0.001$). The simplest, most accurate equation ($R^2 = 0.90$; residual SD 48.7 kcal/kg DM) to predict the ME content of DDGS was $2,815 + (94.5 \times \text{crude fat}) + (96.2 \times \text{crude fiber}) - (33.2 \times \text{NDF}) - (66.2 \times \text{ash}) + (25.9 \times \text{starch})$. The results of this study highlight the considerable variation in energy content of commercially available DDGS sources and provide equations based on chemical analysis to predict this variation.

Key Words: DDGS, prediction equations, metabolizable energy

164 Impact of CLA and ractopamine (Paylean) on growth performance and carcass characteristics in finishing pigs fed either corn distillers dried grains with solubles (DDGS) or corn-soy diets. G. D. Gerlemann*, R. B. Hinson¹, D. Pompeu¹, S. N. Carr², M. J. Ritter², B. R. Wiegand¹, G. L. Allee¹, and R. D. Boyd³, ¹University of Missouri, Columbia, ²Elanco Animal Health, Greenfield, IN, ³The Hanor Company, Franklin, KY.

The objective of this 27 d study was to evaluate the feeding of CLA in conjunction with DDGS and ractopamine (RAC) on growth performance and carcass characteristics. Finishing pigs ($n = 1,102$; TR4 \times C22) with an initial weight of (100.6 ± 1.6 kg) were utilized in a $2 \times 2 \times 2$ factorial arrangement via a split-split plot design with the main plot being two diet sources (corn-soy and corn-soy-20% DDGS), the split plot being two levels of RAC (0 and 7.4 ppm), and the split-split plot being two levels of CLA (0 and 0.6%). Pen was the experimental unit, with 6 replicates/trt for a total of 48 pens with 23 pigs/pen. Pen weights and feed disappearance were collected on d 0 and 27. On d 27, intact pens were marketed to a commercial slaughter facility to obtain carcass characteristics. Data were analyzed using the PROC Mixed model of SAS. The model included the fixed effects of diet source, RAC, and CLA and all

interactions. There were no interactions ($P > 0.05$) observed except for a diet source \times CLA interaction for ADFI. Performance was not affected by diet type ($P > 0.05$). RAC increased ADG (1.01 v. 0.86 kg/d; $P < 0.01$), reduced ADFI (2.64 v. 2.76 kg/d; $P < 0.01$), and improved G:F (0.383 v. 0.313; $P < 0.01$). CLA increased ADG (0.95 v. 0.92 kg/d; $P < 0.01$) and improved G:F (0.352 v. 0.344; $P < 0.01$). The ADFI interaction ($P < 0.04$) resulted from an increase in ADFI in the DDGS diets that included CLA. DDGS diets reduced ($P < 0.03$) carcass yield. RAC increased ($P < 0.01$) carcass wt, yield % (74.7 vs. 73.7), loin depth, and % lean (53.0 vs. 52.2) while reducing ($P < 0.01$) backfat depths. CLA reduced yield % (73.9 vs. 74.5; $P < 0.02$) and increased % lean (52.8 vs. 52.5; $P < 0.01$). We suggest that the feeding of RAC and CLA can improve growth and carcass parameters and that the results of feeding DDGS, RAC and CLA are independent of each other.

Key Words: pigs, conjugated linoleic acid, ractopamine

165 Effects of dried distiller grains with solubles (DDGS) and ractopamine on growth performance and carcass characteristics of swine. A. Schinckel, M. Latour, and B. Richert*, *Purdue University, West Lafayette, IN.*

One hundred sixty pigs (88 barrows and 72 gilts) were allocated by initial BW, sex, and litter to a factorial arrangement of treatments consisting of four dietary DDGS treatments and two ractopamine (RAC) treatments. The four DDGS treatments were: (T1) standard corn-soybean meal + 3.0% choice white grease (CWG) diets fed from 34 to 127 kg BW, (T2) diets containing 25% DDGS fed from 34 to 127 kg BW, (T3) diets containing 25% DDGS fed from 34 kg BW to 4 wk prior to market and fed T1 for the last four weeks to market BW, and (T4) diets containing 25% DDGS fed up to 8 wk prior to market and fed T1 diets to market BW. The two RAC treatments were either a control (0 ppm) or 2 wk of diets supplemented with 5 ppm followed by 2 wk of 10 ppm RAC. There were 5 pigs/pen and 4 pens/treatment. Three pigs/pen were transported to the Purdue Meats Laboratory for carcass data and tissue harvesting. Pen feed intake and individual live weights were recorded every 14 days. All diets meet or exceeded the 1998 NRC requirements for swine and were balance on an equal digestible lysine:ME ratio by phase. Pig ADG (972 vs 922 g/d; $P < 0.06$) and BW (78.4 vs 75.9 kg; $P < 0.04$) during the grower period prior to the initiation of the 8 wk withdrawal were less for pigs fed 25% DDGS compared to T1. Withdrawal programs improved ADG such that at the end of the experiment final BW were similar for the T1 and T4, both greater than T2 ($P < 0.05$), with T3 being intermediate (128.5, 123.8, 127.5, and 128.6 kg BW for T1-T4, respectively). Growth performance improved across all treatments with RAC, resulting in greater ADG ($P < 0.001$), final BW (129.3 vs 124.9 kg; $P < 0.01$), and carcass yield (75.5 vs 74.4%; $P < 0.001$). The differential between feeding 25% DDGS diets during all of the grow-finish period without RAC compared to T1 with a RAC step-up program was 10.9 kg of final BW and 9.9 kg of carcass weight. Adding a 4-wk RAC step-up program while feeding 25% DDGS throughout the grow-finish period can return performance to levels similar to non-RAC grow-finish control diets.

Key Words: swine, dried distillers grains with solubles, ractopamine

166 Effects of excess dietary protein from soybean meal and dried distillers grains with soluble in nursery pigs. S. M. Williams*, J. D. Hancock, S. Issa, and T. L. Gugle, *Kansas State University, Manhattan, KS.*

Two experiments were conducted to determine the effects of excess dietary protein in diets for nursery pigs. For Exp. 1, 105 pigs (average initial BW of 10.4 kg) were used in a 28-d growth assay. The pigs were weaned, blocked by weight, and allotted by sex and ancestry with 7 pigs/pen and 5 pens/treatment. All pigs were fed a common diet for 14 d post weaning and the experimental treatments for the next 28 d. Treatments were corn-soybean meal-based diets formulated to 22.5, 25.0, and 27.5% CP. Overall ADG, ADFI, and G:F were not affected when CP was increased from 22.5 to 27.5% ($P > 0.19$). For Exp. 2, 105 pigs (average initial BW of 10.0 kg) were used. The pigs were weaned, allotted to pens as in Exp. 1, and fed a common diet for the first 14 d post weaning. For the next 28 days, the pigs were fed a corn-soybean meal control (23% CP), a diet with 30% DDGS (25% CP), and a corn-soybean meal diet formulated to the same CP concentration as the DDGS treatment (i.e., 25% CP). Overall ADG, ADFI, and G:F of pigs fed the control diet were not different than that of pigs fed the high CP treatments ($P > 0.12$). However, pigs fed the DDGS treatment had lower G:F than pigs fed the corn-soy diet with the same CP content ($P < 0.04$). For Exp. 1, ADG was 592, 570, and 577 g/d, ADFI was 876, 849, and 843 g/d, and G:F was 676, 671, and 684 g/kg for the 22.5, 25.0, and 27.5% CP treatments. For Exp. 2, ADG was 585, 587, and 545 g/d, ADFI was 861, 858, and 834 g/d, and G:F was 679, 684, and 653 g/kg for the control, corn-soy diet with 25% CP, and 30% DDGS diet with 25% CP. Our results indicate that feeding nursery pigs diets with as much as 27.5% CP will not decrease growth performance. Therefore, any loss of growth performance in nursery pigs fed diets with as much as 30% DDGS should not be blamed on an excess of dietary CP.

Key Words: nursery pigs, DDGS, excess dietary crude protein

167 (Invited) Measurement and quantification of fiber components in dietary ingredients. G. C. Fahey*, *University of Illinois, Urbana.*

If fibrous ingredients are to become a mainstay of the pig diet, a complete understanding of dietary fiber structure, function, and metabolism is necessary akin to what is known of the same characteristics for the macronutrients. What is 'fiber'? The definition is continually expanding. Most fibers are plant-based and fall into either the cell content or the cell wall category. Fibers in cell contents include most oligosaccharides and resistant starches, compounds that only recently have been recognized as 'fiber'. Fibers in cell walls include insoluble components (cellulose, select hemicelluloses, and lignin) and soluble components (select hemicelluloses, pectins, gums, and beta-glucans). Then there is 'animal fiber'. It is found in copious amounts in connective tissue present in animal protein meals, is made up of chondroitin sulfate and hyaluronic acid primarily, and must be fermentatively digested if the animal is to gain any nutritive value from it. How are we to measure all of these compounds, and which ones should we measure? Precise quantification of fibrous components is required in order that proper dietary formulas can be constructed to optimize pig nutrition at select physiological states. A number of robust techniques exist for measurement of dietary fibers, but these have yet to be widely embraced by the swine nutrition community in the U.S. Crude fiber and detergent fiber are measured today, but values resulting from these assays will be of

limited use if we are to include the plethora of new carbohydrate-based compounds and ingredients in swine diets of the future. The latest information on these compounds and the techniques used to measure them will be discussed.

Key Words: fiber, fiber analysis, swine

168 (Invited) Digestibility of dietary fiber in distillers co-products fed to growing pigs. H. H. Stein*, *University of Illinois, Urbana.*

The concentration of fiber in distiller co-products is approximately 3 times greater than in corn. The average concentration of crude fiber, ADF, and NDF in corn distillers dried grains with solubles (DDGS) is 6.6, 11.1, and 41.2%, respectively, whereas sorghum DDGS contains 9.8, 25.0, and 47.9% of these components. The majority of the fiber in both corn DDGS and in sorghum DDGS is insoluble dietary fiber (IDF), whereas less than 20% is soluble dietary fiber (SDF). The apparent ileal digestibility (AID) of total dietary fiber (TDF), IDF, and SDF in corn DDGS is 28.9, 20.0, and 64.4%, respectively, and the apparent total tract digestibility (ATTD) of TDF, IDF, and SDF are 48.8, 41.3, and 90.9%. For sorghum DDGS, the AID and ATTD of TDF, IDF, and SDF are 15.9 and 39.2, 4.8 and 28.6, and 63.4 and 90.6%, respectively. For corn distillers dried grains (DDG), the AID and ATTD of TDF are 0.7 and 43.8%, respectively. The relatively high concentration of dietary fiber in DDGS will result in an increase in the concentration of dietary fiber in diets containing DDGS. As an example, the concentration of TDF in a typical corn-soybean meal diet is approximately 12%, but if 30% corn DDGS is added to this diet, the concentration of TDF will increase to approximately 17%. However, the AID of TDF in the diet is not influenced by the addition of DDGS, but the ATTD of TDF is slightly reduced (from 66 to 55%). The total amount of energy that the pigs obtain from dietary fiber will, therefore, increase when DDGS is used in the diet. The relatively high AID of TDF that is observed in corn-soybean meal diets as well as in corn-soybean meal-DDGS diets indicate that there is a substantial fermentation taking place in the small intestine. A large proportion of the SDF disappears before the end of the small intestine, but there is also some disappearance of IDF in the small intestine. This observation demonstrates that a substantial microbial population resides in the upper gut. It is possible that the size of this population will increase if pigs are fed high fiber diets for a long period of time, but this aspect of fiber digestibility is poorly understood.

Key Words: dietary fiber, distillers co-products, pigs

169 (Invited) Digestion of carbohydrates and utilization of energy in pigs and sows fed diets with contrasting levels and physiochemical properties of dietary fiber. K. E. B. Knudsen* and H. Jørgensen, *Aarhus University, Department of Animal Health and Bioscience, Tjele, Denmark.*

Dietary fiber (DF) is an important component of all but a few feedstuffs used in the feeding of swine. DF is primarily found in the plant cell wall and consists of a series of polysaccharides often associated and/or substituted with proteins and phenolic compounds. The composition of the DF matrix (types and organization of the polysaccharides and the degree of lignification) has a significant influence on the physiochemical properties of the feed. Feedstuffs high in soluble DF generally have a higher swelling and water binding capacity than feedstuffs that are high in insoluble DF. In some cases, i.e. rye, high levels of soluble DF

may also enhance the viscosity in the gut. DF polysaccharides are not degraded by the endogenous carbohydrases secreted to or present in the intestinal brush border in the small intestine but to a variable extent degraded by the microflora permanently colonizing the stomach and the small and large intestine. The large intestine is the main site for microbial degradation of DF polysaccharides of which the major part is broken down in cecum and proximal colon. Factors that limit the degradation of DF in the large intestine are the degree of lignification of the DF and the chemical structure of the DF polysaccharides. Sows have a higher capacity to degrade DF polysaccharides, which presumably is due to a longer retention time in the former. Nevertheless, DF has by far the largest negative impact on the digestibility of nutrients in the small and large intestine as well as it influences the proportion of energy absorbed as glucose or short-chain fatty acids (SCFA). A sizeable proportion of the energy is lost during the conversion from carbohydrates to SCFA in the gut, and since the utilization of energy absorbed as SCFA is lower than that of glucose, the overall energy utilization decreases in response to more energy being absorbed from the large intestine.

Key Words: carbohydrates, dietary fiber, growing pigs

170 (Invited) Factors to consider when using higher levels of fiber in diet formulation. J. F. Patience*, *Iowa State University, Ames.*

The majority of the US pig herd has moved to, and probably will continue to move to, higher dietary fiber levels. Concurrently, other changes in diet composition are occurring as well, including the use of more co-products of the ethanol and human food sectors. With so many changes taking place in practical diet formulation, nutritionists are faced with a growing number of formulation issues, from inconsistency of ingredient nutrient composition to often conflicting research results. The increase in dietary fiber is troubling for a number of reasons. Higher fiber leads to lower dietary energy density, or an increase in higher energy ingredients, such as fats and oils. Changes in dietary fiber may affect the health and function of the gastrointestinal tract, with different sections being affected differently. Fiber is not an inert entity, and even the selection of chemical descriptions of dietary fiber remain controversial. Another issue is the interpretation of research results, when dietary fiber levels are increased. This presentation will address these and other issues associated with the increased use of dietary fiber in practical diets.

Key Words: swine, fiber

171 Effects of dietary astaxanthin on the growth and carcass characteristics of finishing pigs. J. R. Bergstrom*, J. L. Nelssen, T. A. Houser, J. A. Gunderson, A. N. Gipe, J. Y. Jacela, J. M. Benz, R. C. Sulabo, M. D. Tokach, R. D. Goodband, J. M. DeRouchey, and S. S. Dritz, *Kansas State University, Manhattan.*

A total of 48 barrows (initially 97.6 kg) were used to evaluate the effects of increasing dietary astaxanthin (0, 5, 10, and 20 ppm) on late-finishing pig performance and carcass characteristics. Pigs were blocked by BW and randomly allotted to 1 of 4 diets in a 26-d experiment. There were 2 pigs/pen and 6 pens/treatment. Pigs were fed simple corn-soybean meal-based diets with 0, 5, 10, or 20 ppm added astaxanthin. Increasing astaxanthin did not influence ($P > 0.25$) ADG (956, 1010, 923, and 905 g/d) or G/F (0.32, 0.33, 0.33, and 0.32). However, ADFI (3027, 3071, 2832, and 2813 g/d) tended (linear; $P < 0.10$) to decrease with increasing astaxanthin. Pigs fed astaxanthin had decreased ($P < 0.03$

and $P < 0.06$, respectively) average (25, 22, 22, and 22 mm) and 10th rib (21, 17, 17, and 18 mm) backfat depth compared with control pigs. Pigs fed astaxanthin tended ($P < 0.10$) to have an increased percentage of fat-free lean (53.2, 55.6, 55.5, and 54.5%), and pigs fed 5 or 10 ppm were the leanest (quadratic, $P < 0.10$). At 24 h postmortem, pigs fed astaxanthin tended ($P < 0.06$ and $P < 0.08$, respectively) to have lower L^* (60.3, 55.3, 58.9, and 56.2) and b^* (15.8, 14.8, 14.4, and 15.1) for the cut surface of the 10th rib loin muscle, indicating a darker color. At the time of the study, the improved carcass characteristics of pigs fed astaxanthin resulted in a numeric increase in the net profit per pig of \$2.44 and \$1.95 for those fed 5 and 10 ppm astaxanthin, respectively. In conclusion, growth performance of pigs fed 5, 10, or 20 ppm astaxanthin was not different from that of pigs fed the control diet. However, the improved carcass characteristics observed could be economically beneficial to pork producers. Additionally, the potential for improvements in pork color could result in improved consumer acceptance of fresh pork. These results warrant further research.

Key Words: astaxanthin, carcass characteristics, pork color

172 Effects of feeder design and changing the availability of water from a wet-dry feeder at 4 and 8 weeks prior to market on growth and carcass characteristics of finishing pigs. J. R. Bergstrom*, M. D. Tokach, S. S. Dritz, J. L. Nelssen, J. M. DeRouchey, and R. D. Goodband, *Kansas State University, Manhattan*.

A total of 1,296 pigs (PIC, 337 × 1050; initially 19 kg) were used to evaluate effects of conventional dry (CD) or wet-dry (WD) feeder designs and changing availability of water from a WD feeder at 4 and 8 wk prior to market on growth and carcass characteristics. There were 27 pigs per pen (14 barrows and 13 gilts) and 24 pens per feeder-type. Pigs were fed identical corn-soybean meal diets with 15% DDGS. Pens with a WD had a separate cup waterer, but the WD provided the sole water source until d 69. The water supply to the WD was shut off in 8 pens on d 69 (WD8) and another 8 pens on d 97 (WD4) and the cup waterer was turned on. For the remaining 8 WD, the WD provided the sole water source for the entire experiment (WD0). From d 0 to 69, pigs using the WD had improved ($P < 0.05$) ADG (824 vs. 787 g/d), ADFI (1.86 vs. 1.80 kg/d), G/F (0.45 vs. 0.44), and d 69 BW (76.7 vs. 74.1 kg). Overall (d 0 to 124), pigs using WD0 had greater ($P < 0.05$) ADG, ADFI, final BW, and HCW than all other treatments. Pigs using WD4 had greater ($P < 0.05$) ADG than CD, and WD8 was intermediate. Pigs using WD4 had greater ($P < 0.05$) ADFI than WD8, and CD was intermediate. Pigs using WD0 had poorer ($P < 0.05$) G/F than WD8, and CD and WD4 were intermediate. Backfat depth of pigs using WD8 was reduced ($P < 0.05$) compared to all other treatments, and their loin depth was greater ($P < 0.05$) than CD and WD4. Loin depth of pigs using WD0 was also greater ($P < 0.05$) than CD. Margin-over-feed cost was numerically greatest for pigs using WD8. In conclusion, pigs using WD0 had better growth rates than pigs using CD, WD4, or WD8. Although measures of carcass leanness were improved with WD8, the reduction in growth for this treatment during the last 8 wk indicates that further research is necessary to improve this technique of modifying growth.

Key Words: feeders, growth, pigs

173 Comparison of several dietary fats for finishing pigs. Y. Liu*, D. Y. Kil, V. G. Perez-Mendoza, and J. E. Pettigrew, *University of Illinois, Urbana*.

A recent report showed higher swine NE for choice white grease (CWG) than for soybean oil (SBO). The present study was conducted to determine whether practical responses confirm that difference and to extend the observations to other fat sources. Pigs ($n = 144$, 73.0 ± 4.0 kg BW) were randomly assigned to 6 dietary treatments: 1) a corn-soybean meal diet without added fat (C), 2) C + 6% SBO, 3) C + 6% CWG, 4) C + 6% palm oil (PO), 5) C + 6% animal-vegetable blend (AVB), and 6) C + 6% tallow (TA). The pigs were in 8 replications with 3 pigs/pen. There were 2 diet phases, d 1-19 for phase I and d 19-47 for phase II. Dietary treatments within each phase were formulated to contain equivalent standardized ileal digestible lysine/Mcal of ME. The ADG, ADFI and G:F were measured during each phase and overall. At the beginning and end of this experiment, ultrasound was used to measure backfat depth at the last rib (BFLR) and 10th rib (BFTR), and muscle depth at the last rib (MDLR) and 10th rib (MDTR). The changes of BFLR, BFTR, MDLR, and MDTR between initial and final measurements were calculated. The results showed that pigs fed fats (SBO, PO, AVB, CWG, and TA) had higher ($P < 0.01$) G:F in each phase and overall, higher ($P < 0.01$) ADG in phase I, and lower ($P < 0.01$) ADFI in phase II and overall than pigs fed the control diet. Pigs fed CWG had greater ($P < 0.05$) ADG than these fed SBO in phase I. In phase II and overall, pigs fed SBO had lower ($P < 0.05$) ADFI than pigs fed PO. The addition of fats had no effect on carcass measurements compared with the control diet, but pigs fed PO had greater ($P < 0.05$) increase in BFTR compared with SBO and AVB. In conclusion, different fats produced different practical results, consistent with different energy values. It is not clear from these data whether CWG has greater energy than SBO.

Key Words: dietary fats, growth performance, growing-finishing pigs

174 (National Pork Board Research Award) Soybean meal level modifies the impact of high immune stress on growth and feed efficiency in pigs. M. E. Johnston¹, R. D. Boyd*¹, C. E. Zier-Rush¹, and C. E. Fralick², ¹*The Hanor Company, Franklin, KY*, ²*Swine-Tek Research, Van Wert, OH*.

This study was conducted to verify the SID lysine requirement of pigs fed Paylean (PLN) for 21 d, using carcass growth and G:F ratio as primary criteria. A second objective was to verify previous work from our lab that whole-body growth (WB) was promoted equally by low and high dietary SBM levels while carcass growth (Carc) was constrained by high SBM content. A total of 420 Camborough × TR-4 castrates (98.3 ± 3.8 kg) were allotted to diet in a 4×2 factorial arrangement (48 pens, 6 pens/diet). Four SID lysine levels were prepared (0.65, 0.75, 0.85, 0.95% SID) by summit blend; each having 5 PPM PLN. Diets were formulated with only (a) SBM (H-SBM) or (b) reduced SBM (L-SBM) plus lysine, threonine. Pigs were unexpectedly infected with diseases that trigger systemic inflammation. Diagnostic results confirmed pigs as PRRS and PCV2 (circovirus) positive; PCV2 tissue lesions were present. Mortality and morbidity was 6 times normal (12.7%) for 16 weeks. The inflammatory nature of these viruses is evident from the presence of circulating pro-inflammatory cytokines. The main effect of SID lysine was not significant ($P > 0.25$) for WB ADG or G:F, however, the effect of SBM level was ($P < 0.05$). H-SBM pigs grew faster (.99 vs

.90 ± 0.03 kg/d, WB), were more efficient (.365 vs .337 ± 0.009, WB) and had greater Carc gain (14.2 vs 12.7 kg). The advantage of H-SBM, under conditions of high immune stress, was observed for Carc ADG and G:F (+12.8, +9.7% respectively). The beneficial effect of H-SBM was evident at each lysine level for WB ADG and G:F (SBM x lysine, $P > 0.10$). Carcass yield was low but similar for SBM level ($P > 0.90$, 74.7%), which is contrary to our results with healthy pigs. The SID lysine requirement (G:F) for the H-SBM regimen was 0.95%, using WB and Carc G:F. This estimate was lower for pigs fed L-SBM diets (0.85%). Some component of SBM appears to modify the impact of high immune stress on G:F ratio and the SID lysine requirement. We conclude that H-SBM level significantly reduces the negative effect of inflammatory disease on ADG and G:F. The mechanism is unclear but the anti-inflammatory SBM isoflavones may be involved.

Key Words: pigs, soybean meal, immune stress

175 Effect of ractopamine HCl (Paylean) feeding programs on growth performance and carcass characteristics of finishing pigs. 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 1,099 pigs (BW=94 kg) were used to evaluate the effect of ractopamine HCl (RAC) feeding programs on growth and carcass traits of finishing pigs. Pigs were randomly assigned to 1 of 3 treatments (14 pens/treatment; 26 pigs/pen) balanced by average BW within gender. Treatments were a basal diet with: 1) 0 ppm RAC for 28 d (control), 2) 0 ppm RAC from d 0 to 7 and 4.5 ppm RAC from d 7 to 28 (constant), and 3) 4.5 ppm from d 0 to 14 and 6.75 ppm from d 14 to 28 (step-up). Pig ADG, ADFI, and G:F were determined weekly, and carcass data were collected. From d 0 to 7, step-up pigs had improved ($P < 0.04$) ADG, ADFI, and G:F compared to all other treatments. From d 7 to 28, pigs fed the constant and step-up treatments had greater ($P < 0.01$) ADG (942 and 858 vs 755 g) and G:F (0.36 and 0.35 vs 0.28) than control pigs. However, step-up pigs had lower ($P < 0.01$) ADG and ADFI (2.48 vs 2.65 kg) but similar ($P > 0.27$) G:F compared to constant pigs. Overall, ADFI ($P = 0.15$) was similar between treatments, but RAC-fed pigs had greater ADG than control pigs ($P < 0.01$; 949 and 932 vs 796g) which led to improved G:F ($P < 0.01$; 0.36 and 0.36 vs 0.30). Overall performance of RAC-fed groups was similar. RAC-fed pigs had heavier carcass ($P < 0.05$; 91.6 and 90.4 kg vs 87.0 kg) and tended to have greater yield ($P < 0.10$) than control pigs. Among the 3 groups, step-up pigs had the greatest ($P < 0.05$) percentage lean (57 vs 56% and 55%), loin depth (6.5 vs 6.2 and 6.1cm), and FFLI (50.8 vs 50.1 and 50.0), and the lowest BF depth ($P < 0.01$; 1.57 vs 1.72 cm and 1.73cm). Both RAC-fed groups had greater ($P < 0.05$) revenue than control pigs. Feed cost was highest ($P < 0.01$) in the constant group and lowest in the control. Income over feed cost tended ($P < 0.07$) to be higher for RAC-fed pigs than control pigs. In conclusion, feeding a constant level of 4.5 ppm RAC for 21 d improved growth similar to feeding the 28-d step-up program; however, the 28-d RAC step-up program resulted in additional improvement in carcass traits.

Key Words: growth, pig, ractopamine

176 Evaluation of PEP2 in nursery pig diets. A. J. Myers*¹, M. D. Tokach¹, R. D. Goodband¹, S. S. Dritz¹, N. W. Shelton¹, G. Papadopoulos¹, J. M. DeRouchey¹, J. L. Nelssen¹, and D. McKilligan², ¹*Kansas State University, Manhattan*, ²*Protein Resources, West Bend, IA*.

A total of 300 nursery pigs (PIC 327 × 1050, initially 5.4 kg and 21 d of age) were used in a 25-d study to determine the effects of PEP2 (proteins enzymatically processed) on growth performance of weaned pigs. PEP2 is a combination of refined porcine intestinal mucosa derived from heparin production, co-dried with enzymatically processed vegetable protein. There were 5 dietary treatments: a negative control containing no specialty protein sources, the negative control diet with 4, 8, or 12% PEP2 in phase 1 and 2, and a positive control containing 4% spray-dried animal plasma (SDAP) in Phase 1 and 4% select menhaden fish meal in Phase 2. Phase 1 diets were fed in pellet form from d 0 to 11. Phase 2 diets were fed in meal form from d 11 to 25. In Phase 1, increasing PEP2 improved (linear; $P < 0.01$) G:F. However, pigs fed SDAP had greater ($P < 0.05$) ADG and G:F than pigs fed PEP2 diets. In Phase 2 and overall, increasing PEP2 increased (quadratic; $P < 0.01$) ADG, and G:F with the greatest response observed at 4% PEP2. Pigs fed PEP2 had greater ($P < 0.01$) ADG and ADFI than pigs fed the positive control diet containing fish meal and pigs fed the negative control diet. Overall (d 0 to 25), pigs fed the positive control diet and those fed PEP2 had improved ADG and G:F than pigs fed the negative control. In conclusion, although pigs fed SDAP in Phase 1 had better ADG and G:F than pigs fed the increasing levels of PEP2, in Phase 2, pigs fed 4% PEP2 had greater ADG and G:F than pigs fed 4% select menhaden fish meal.

Table 1. Effects of PEP2 on nursery pig performance

item	Negative Control	4% PEP2	8% PEP2	12% PEP2	Positive Control	SEM	P-value	PEP2 Linear	PEP2 Quadratic
D 0 to 11									
ADG, g	193	187	190	195	221	9.4	0.152	0.85	0.56
G:F	0.97	0.99	0.98	1.00	1.07	0.047	0.016	0.48	0.89
D 11 to 25									
ADG, g	371	433	426	416	400	13.7	<0.01	<0.01	<0.01
G:F	0.67	0.75	0.73	0.73	0.74	0.015	<0.01	<0.01	<0.01
D 0 to 25									
ADG, g	293	324	322	319	321	8.6	0.036	0.03	<0.01
G:F	0.73	0.80	0.78	0.79	0.81	0.008	<0.01	0.02	<0.01

Key Words: pig, fish meal, spray dried animal plasma

177 Growth performance, nutrient digestibility, intestine morphology, blood profiles, and microbiota in weaning pigs fed single cell protein. J. P. Wang*¹, J. D. Kim², J. I. Kim², J. H. Lee¹, T. X. Zhou¹, and I. H. Kim¹, ¹*Dankook University, Department of Animal Resource & Science, Choeran, Choongnam, Korea*, ²*CheilJedang. Corp. Bio Business, Seoul, Korea*.

A total of 120 weaned barrows (8.47±0.49 kg; 28 d of age) were used in a 35-d growth study to evaluate the effects of single cell protein (SCP) on growth performance, apparent total tract digestibility (ATTD) of DM and N, blood immunoglobulin G (IgG), uric acid concentration, small intestinal morphology, and microbiota. Pigs were randomly allotted to 3 treatments according to their BW (5 pigs/pen, 8 replicates/treatment). Dietary treatments were corn-soybean basal diet and basal diet supplemented with SCP at 1.5% (SCP1.5) and 3.0% (SCP3.0), respec-

tively. The SCP were obtained from the yeast culture as a by-product of making lysine (CJ feed), and the diets were fed during the experiment into 3 phases: d 0 to 7, 7 to 21, and 21 to 35. Supplementation of SCP at 1.5% increase ($P < 0.05$) the ADFI from d 15 to 21. The ADG and G:F from d 22 to 35 linearly enhanced as SCP levels increased ($P < 0.05$). Pigs fed the SCP at 3% had the greatest ADG during the overall period ($P < 0.05$). The ATTD of DM and N linearly increased as dietary SCP levels increased ($P < 0.05$) on d 21 and 35 d. The blood were taken at the end of each phase, the blood immunoglobulin G (IgG) concentration on d 7 and 21 were greater in pigs fed SCP at 3.0% (linear, $P < 0.05$) when compared to other two groups. During the whole experiment, there was no effect of treatment on the presence of *Lactobacillus* and *Escherichia coli* in both ileal digesta and feces. In duodenum, the villi and villous height/crypt depth ratio were higher in SCP containing diets (linear, $P < 0.05$), but the crypt depth was unaltered. No differences were observed in small intestine length, and weight. These results suggest that supplementation SCP in the weanling pigs diet can improve growth performance, and nutrient digestibility during the mid to latter phase of nursery period, and SCP also had potential to stimulate the immune system after 2 wk of post-weaning.

Key Words: intestine morphology, single cell protein, weanling pigs

178 Effect of low oligosaccharide soybean meal in diets of early weaned pigs. S. K. Baidoo¹, R. B. A. Dahlen*¹, L. Anil¹, and A. Doering², ¹*Southern Research and Outreach Center, University of Minnesota, Waseca, MN*, ²*Agricultural Utilization and Research Institute, Waseca, MN*.

An experiment was conducted to determine the effect of low oligosaccharide soybean meal (LOSBM) on growth performance, blood urea nitrogen, and intestinal morphology in early weaned pigs. One hundred and twenty eight 18-d old pigs (6.0 ± 0.39 kg BW) were assigned randomly to one of four dietary treatments in a 28-d nursery study. Diets were a corn-SBM control diet supplemented with fish meal, whey powder and spray dried porcine plasma (Diet 1); 50% SBM in Diet 1 was replaced by LOSBM (Diet 2); 100% SBM in Diet 1 was replaced by LOSBM (Diet 3); and LOSBM replacing all SBM in Diet 1 without supplementation of fish meal, whey powder and spray dried porcine plasma (Diet 4). Diets were fed in three phases (phase 1 = 7 d; phase 2 = 14 d; and phase 3 = 7 d). Blood samples were collected via vena puncture on d 0, 7, 14, and 28 of the study period for blood urea nitrogen analysis. Six pigs per dietary treatment were harvested and intestinal morphology was determined at 25%, 50%, and 75% along the gastrointestinal tract on d 28 of the study. A summary of the overall results is presented in Table 1. Replacement of conventional SBM with low oligosaccharide soybean meal diets without fish meal, whey powder, and spray dried porcine plasma did not influence the growth performance of early weaned pigs. In addition, weaned pigs fed diets with 100% LOSBM without fish meal, whey powder, and spray dried porcine plasma tended to have a higher villi height at ileum. However, pigs fed LOSBM with fish meal, whey powder, and spray dried porcine plasma tended to have higher levels of BUN compared to pigs fed the control diet.

Table 1. Effect of low oligosaccharide soybean meal on performance of early weaned pigs.

Criteria	Diet 1	Diet 2	Diet 3	Diet 4	SEM	P-value
Start wt, kg	6.0	6.0	6.1	6.0	0.39	0.99
End wt, kg	17.5	18.3	17.5	16.8	0.69	0.12
ADG, kg	0.36	0.39	0.36	0.34	0.02	0.44
ADFI, kg	0.51	0.56	0.53	0.50	0.02	0.44
G:F, kg/kg	0.73	0.73	0.73	0.73	0.05	0.35
BUN, mg/dL	10.7 ^a	11.9 ^{ab}	14.7 ^a	13.1 ^{ab}	0.72	0.06
Villi height, μ m	593 ^a	720 ^{ab}	649 ^{ab}	816 ^b	62.57	0.06
Crypt depth, μ m	307	320	326	294	26.62	0.63

^{a b}Within a row, means with different superscripts tend to differ ($P < 0.10$).

Key Words: growth, low oligosaccharide soybean meal, swine

179 Effect of milk chocolate product (MCP) on week-one feed intake and growth performance of weanling pigs. V. D. Naranjo*, T. D. Bidner, and L. L. Southern, *Louisiana State University, Agricultural Center, Baton Rouge*.

The effect of partial or total replacement of dried whey (DW; 70% lactose) with MCP (20% lactose, 60% total sugars) on wk-1 feed intake and growth performance of weanling pigs was determined. Diets contained 1.60, 1.40, 1.40, and 1.20% total Lys for phases 1 (d 0 to 7), 2 (d 7 to 14), 3 (d 14 to 21), and 4 (d 21 to 35). In Exp. 1 (5 reps of 5 pigs per pen, initial BW = 6.5 ± 0.8 kg and 24 ± 2 d of age) and 2 (6 reps of 5 pigs per pen, initial BW = 6.0 ± 0.9 kg and 19 ± 2 d of age) pigs were assigned to: 1) negative control (NC), no lactose added; 2) positive control (PC) with DW; 3 and 4) 25 and 50% replacement of the level of DW of the PC diet with MCP (25MCP and 50MCP, respectively). The level of DW or their combinations with MCP were 20, 10, and 5% for phases 1, 2, and 3, respectively. A common diet (no lactose) was fed in phase 4. In Exp. 3 (7 reps of 4 pigs per pen, initial BW = 6.3 ± 1.3 kg and 21 ± 2 d of age) pigs were assigned to: 1) NC, 2) PC, and 3) 100% replacement of the level of DW of the PC diet with MCP (100MCP). In the combined data from Exp. 1 and 2 (treatment \times Exp., $P > 0.10$), daily collected feed intake was increased ($P < 0.10$) from d 3 to 7 (PC), on d 2, 3, 4, and 7 (25MCP), and from d 2 to 7 (50MCP) compared with pigs fed the NC diet. During phase 1, ADG and ADFI were increased ($P < 0.10$) for pigs fed the PC (165 and 265 g/d), 25MCP (171 and 255 g/d), and 50MCP (181 and 276 g/d) diets compared with pigs fed the NC diet (133 and 211 g/d). Overall, pigs fed the PC and 50MCP diets had increased ($P < 0.10$) ADFI compared with pigs fed the NC diet (762, 759, vs. 716 g/d), but similar to pigs fed the 25MCP diet (737 g/d). In Exp. 3, daily collected feed intake was increased ($P < 0.10$) from d 2 to 5 (PC) and on d 1 and 2 (100MCP) compared with pigs fed the NC diet. During phase 1, ADFI was increased ($P < 0.10$) for pigs fed the PC and 100MCP diets compared with pigs fed the NC diet (355, 337 vs. 293 g/d). Overall, ADG, ADFI, and G:F were not affected ($P > 0.10$). In conclusion, partial or total replacement of DW with MCP does not affect growth performance of weanling pigs; thus, MCP could be considered as an alternative to DW.

Key Words: pigs, sucrose, lactose

180 Application of a blend of dietary antioxidants in nursery pigs fed either fresh or oxidized corn oil or DDGS. R. J. Harrell*, J. Zhao, G. Reznik, D. Macaraeg, T. Wineman, and J. Richards, *Novus International Inc., St. Charles, MO.*

This study evaluated the effects of a blend of antioxidants (AOX, AGRADOPLUS, Novus International Inc., St Charles, MO) with different sources of corn oil in nursery pigs. At weaning (~20 d of age), pigs were blocked by weight and sex and assigned to a pen (20-25 pigs/pen) and was randomly assigned to either 0 or AOX from 0 to 10 d postweaning. At 10 d, within an AOX treatment, pen was randomly assigned to one of 3 fat sources (fresh corn oil vs oxidized corn oil vs DDGS) to provide 7 pens/treatment. Pigs were fed 20 and 30% inclusion rate of DDGS from 10 to 21 and 21 to 42 d, respectively. Oxidized oil was fed to provide 7.5 meq peroxide value/kg diet. Nutrient adequate diets were fed ad libitum with equal calculated dietary fat levels by the addition of fresh corn oil. From 0 to 10 d postweaning, no differences in performance were detected with the addition of AOX ($P > 0.40$). From 10 to 42 d, pigs fed AOX tended to have 2.5% higher ADG (492 vs 480 ± 4 ; $P < 0.06$) and 2.5% higher ADFI (770 vs 751 ± 6 ; $P < 0.05$) compared to controls. From 10 to 42 d, pigs fed fresh oil had higher ADG (507 ± 5) and ADFI (792 ± 8) than either pigs fed oxidized oil (ADG 480 ± 5 and ADFI 751 ± 8 ; $P < 0.05$) or pigs fed DDGS (ADG 471 ± 5 and ADFI 739 ± 8 ; $P < 0.05$). Day 42 ending bodyweights tended to be heavier for pigs fed AOX (23.87 vs 23.50 ± 0.14 , $P < 0.07$). Pigs fed fresh oil had 4.8% heavier ending bodyweights than pigs fed DDGS (24.35 vs 23.18 ± 0.17 , $P < 0.01$) and 3.5% heavier ending bodyweights than pigs fed oxidized oil (24.35 vs 23.52 ± 0.17). No differences were detected in GF between fat sources ($P > 0.88$) or AOX ($P > 0.82$). There were no significant interactions detected between AOX and fat source on pig performance ($P > 0.26$). In summary, pigs fed DDGS had similar performance as pigs fed oxidized oil and both sources were lower in performance than pigs fed fresh corn oil. Dietary addition of AOX improved pig growth performance regardless of fat source.

Key Words: swine, antioxidant, DDGS

181 Effects of meal or pellet diet form on finishing pig performance and carcass characteristics. M. L. Potter, S. S. Dritz, M. D. Tokach, J. M. DeRouchey, R. D. Goodband, J. L. Nelssen, and J. A. Barnes*, *Kansas State University, Manhattan.*

The effects of feeding diets in meal or pellet form on finishing pig performance were determined in 2 experiments. Within each experiment's diet formulation (corn-soybean meal-based diets in Exp. 1 and diets with alternative ingredients in Exp. 2) and particle size were identical between treatments. In Exp. 1, 1,072 pigs (27.5 kg) were used in a 112-d trial. Treatments were arranged in a 2×2 factorial (10 pens per treatment) with main effects of diet form and gender. Pelleted diets were analyzed and contained 25% fines with a pellet durability index of 87%. There were no gender \times diet form interactions for overall ADG, ADFI, or G:F. Pigs fed pelleted diets had increased ADG (0.92 ± 0.005 vs. 0.87 kg, $P < 0.01$) compared with pigs fed meal diets. There was no difference ($P = 0.69$) in ADFI, but pigs fed pelleted diets had a 5.4% improvement (0.37 ± 0.002 vs. 0.35 , $P < 0.01$) in G:F compared with pigs fed meal diets. Pigs fed pellets were 6.2 kg heavier ($P < 0.01$) at off test and had heavier (97.3 ± 0.60 vs. 92.2 kg, $P < 0.01$)

carcasses than pigs fed meal diets. Backfat depth was unaffected ($P = 0.19$) by diet form, but pigs fed pelleted diets tended to have lower percentage lean (52.8 ± 0.13 vs. 53.2% , $P = 0.07$) and loin depth (61.0 ± 0.35 vs. 62.0 mm, $P = 0.09$) than pigs fed meal diets. In Exp. 2, 1,214 pigs (26.4 kg) in barrow or gilt pens were used in a 42-d trial (11 pens per treatment). Pelleted diets were analyzed and contained 35% fines with a pellet durability index of 80%. Pigs fed pelleted diets had greater (0.93 ± 0.034 vs. 0.89 kg, $P < 0.01$) ADG than pigs fed meal diets. There were no differences ($P \geq 0.13$) in overall ADFI or G:F between pigs fed meal and pelleted diets. While not significant ($P = 0.14$), pigs fed pelleted diets had a numerical BW advantage of 1.9 kg on d 42 compared with pigs fed meal diets. Although feeding a pelleted diet improved ADG compared with feeding a meal diet, the magnitude of the response was inconsistent between trials. Diet formulation did affect pellet quality, which may explain differences between the experiments.

Key Words: growth, pellet, pig

182 Processing conditions affect nutrient digestibility of cold-pressed canola cake for grower pigs. R. W. Seneviratne¹, E. Beltranena^{1,2}, L. A. Goonewardene^{1,2}, R. W. Newkirk³, and R. T. Zijlstra^{*1}, ¹University of Alberta, Edmonton, AB, Canada, ²Alberta Agriculture and Rural Development, Edmonton, AB, Canada, ³Canadian International Grains Institute, Winnipeg, MB, Canada.

Cold-pressed canola cake contains more residual oil than expeller-pressed and solvent-extracted canola meal; however, the nutritional quality is poorly defined. Canola seed was pressed with a non-heated or heated barrel at slow or fast screw speed in a 2×2 factorial arrangement. Seven ileal-cannulated barrows (26 kg BW) were fed at $2.8 \times$ maintenance diets containing 44% of 1 of 4 canola cake samples, expeller-pressed canola meal, canola seed, or a N-free diet in a 7×7 Latin square to measure energy and AA digestibility and calculate standardized ileal digestible (SID) AA and NE content. In 9-d periods involving a 5-d adaptation, and a 2-d feces and 2-d digesta collection, 7 observations per diet were obtained. Cold-pressed canola cake contained 41% CP, 16% ether extract, and 7 $\mu\text{mol/g}$ total glucosinolates (DM basis). Both AID and total tract digestibility of energy in cold-pressed canola cake was 36% higher ($P < 0.05$) in heated vs. non-heated conditions, and 8% higher ($P < 0.05$) in fast vs. slow screw speed, without interaction, indicating that added heat enhances energy digestibility. The AID of energy in canola cake was 13 and 118% higher ($P < 0.05$) than expeller-pressed canola meal and canola seed, respectively. Heat and speed interacted ($P < 0.05$) for SID of AA, but effects were not consistent among AA. The DE and NE content of cold-pressed canola cake was 0.73 and 0.52 Mcal/kg of DM higher ($P < 0.05$), respectively, than expeller-pressed canola meal, and did not differ from canola seed. On average, cold-pressed canola cake contained 4.17 Mcal/kg DE, 2.84 Mcal/kg NE, 0.87% SID Lys, 0.46% SID Met, and 0.79% SID Thr (DM basis). In conclusion, processing conditions greatly affected the digestible nutrient content of cold-pressed canola cake; content of ether extract was an important determinant of the energy value.

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

183 Effect of dietary mannanase supplementation on pig growth performance. B. E. Bass^{*1}, J. W. Frank¹, Z. B. Johnson¹, J. H. Lee², and C. V. Maxwell¹, ¹University of Arkansas, Fayetteville, ²CTCBIO Inc., Seoul, Korea.

Two studies were conducted to determine the effects of feeding diets supplemented with β -mannanase (CTCZYME, CTCBIO Inc.) on growth performance in nursery and grow-finish pigs. For the nursery study, 224 pigs were weaned at an average of 20.6 ± 0.08 d of age (BW = 7.09 kg), penned in groups of 7 pigs/pen and fed a 3-phase diet program (phase 1: 13 d; phase 2: 14 d; phase 3: 13 d). For the grow-finish study, 140 pigs (BW = 30.1 kg) were penned in groups of 5 pigs/pen and fed a 3-phase diet program (phase 1: 30-50 kg; phase 2: 50-90 kg; phase 3: 90-120 kg). In both studies pigs were randomly assigned to one of four treatments: 1) Negative control (NC); 2) 200,000 IU enzyme/kg added to NC (MAN2); 3) 400,000 IU enzyme/kg added to NC (MAN4); and 4) Positive control (NC containing an additional 100 kcal/kg ME from fat; PC). In the nursery study, pigs fed PC had lower ADFI than NC during phase 3 ($P < 0.05$). There was a linear increase in ADG ($P < 0.10$) during phase 3 of the nursery period as the level of enzyme increased. There was also a linear improvement in G:F (0.708, 0.731, and 0.739 for NC, MAN2 and MAN4, respectively; $P = 0.05$) as the amount of enzyme increased during the overall nursery period. Final BW for the nursery study for PC, NC, MAN2 and MAN4 were 29.1, 28.8, 29.4, and 29.4 kg, respectively ($P = 0.59$). During phase 1 of the grow-finish study, there was a linear decrease in ADFI ($P = 0.05$) and linear improvement in G:F ($P = 0.02$) as the level of enzyme increased. During phase 2, there was also a linear decrease ($P = 0.02$) in ADFI as the level of enzyme increased. Overall ADG (1.05 vs. 1.00 kg/d) and BW (124.5 vs. 120.6 kg) were greater in PC compared to NC ($P < 0.01$). There was an overall linear decrease in ADFI (2.91, 2.85, and 2.72 kg/d for NC, MAN2, and MAN4, respectively; $P = 0.05$) as the level of enzyme increased during the grow-finish study. In conclusion, the addition of β -mannanase to diets improved growth performance in both the nursery and grower/finisher due to improved energy utilization.

Key Words: pigs, β -mannanase, enzyme

184 Evaluation of crude glycerol in feed processing of swine diets. M. Shields^{*}, E. van Heugten, J. Odle, and C. Stark, North Carolina State University, Raleigh.

This study evaluated the effect of crude glycerol on feed processing of nursery and finisher diets for pigs. The crude glycerol contained 87.0% glycerol, 9.2% moisture, 1.26% Na, 1.86% Cl, and 280 ppm methanol. In Exp. 1, complex nursery diets (10.5% lactose, 8.5% dried whey, 5% fish meal, 4% blood plasma, 2% blood cells, and 2% poultry fat) were mixed in a double ribbon mixer with glycerol levels of 0, 2.4, and 5.0% replacing corn on a weight basis and pelleted (74°C conditioning temperature (CT) and 3.17 cm die size). In Exp. 2, finisher diets (corn soybean meal based with 3% added fat) were mixed in a horizontal paddle mixer with glycerol at 0, 2.5, and 5.0%, replacing corn on a weight basis to measure diet flow. In Exp. 3, finisher diets were mixed in a double ribbon mixer with glycerol included at 0, 2.5, and 5% replacing corn on a weight basis and pelleted (74°C CT; 3.17 cm die size). A second control feed was pelleted at a standard 85°C CT. There were three replications per treatment for each experiment. In Exp. 1, flowability of the meal increased ($P < 0.001$) linearly with increasing glycerol (32, 31, 26 mm disc size), horsepower decreased ($P = 0.02$) linearly (8.1, 7.7, 7.0), pellet quality (pellet durability index; PDI,

90.2, 93.8, 94.6 %) and modified PDI (included 3 nuts, 68.0, 75.5, 73.5%) increased ($P = 0.001$) linearly, and hot pellet temperature after the pellet die decreased ($P < 0.001$) linearly (81, 79, 77°C). In Exp. 2, flowability increased ($P = 0.03$) linearly (27, 25, 24 mm disc size) with glycerol. In Exp. 3, increasing glycerol linearly increased pellet mill efficiency ($P < 0.01$; 100, 120, 128 kg/(hp×hr)) and PDI ($P = 0.004$; 55.7, 69.6, 81.3%), and decreased hot pellet temperature ($P = 0.05$; 79, 78, and 77°C). Hot pellet temperature (86 vs. 79°C) and PDI (79.5 vs. 55.7%) were greater ($P < 0.001$) and pellet mill efficiency (110 vs. 100 kg/(hp×hr)) tended to be greater ($P = 0.06$) for CT of 85°C compared to 65°C. In conclusion, glycerol supplementation improved flowability of meal and pelleting efficiency of nursery and finishing diets and allowed for pelleting at a lower temperature while maintaining production efficiency and pellet quality.

Key Words: glycerol, pelleting, swine

185 Effects of mix time on diet uniformity and growth performance of nursery pigs. C. B. Paulk^{*}, S.M. Williams, J. D. Hancock, S. Issa, E. F. Mader, S.M. Rogers, A. C. Fahrenholz, L. J. McKinny, and K. C. Behnke, Kansas State University, Manhattan.

Mixing is an important part of creating diets that support maximum rate and efficiency of gain in pigs. However, there is much debate about the degree of mix uniformity actually necessary for optimal pig performance. Therefore, 144 pigs (72 barrows and 72 gilts with an average initial BW of 10.9 kg) were used in a 20-d growth assay to determine the effects of diet mixing time on growth performance in nursery pigs. Pigs were sorted by weight, sex, and ancestry with 6 pigs/pen and 8 pens/treatment. Treatments were a corn-soybean meal-based diet mixed for 0, 0.5, and 5 min. With the salt concentration from 10 diet samples used to calculate a CV for mix uniformity, values were 70, 20, and 23% at the mixer and 21, 21, and 16% at the feeder for the 0, 0.5, and 5 min treatments, respectively. As for growth performance of pigs fed the diets, increasing mix time from 0 to 5 min increased (linear effects, $P < 0.05$) ADG and G:F, but had no effect on ADFI ($P > 0.63$). For pigs fed the 0, 0.5, and 5 min mix time treatments, ADG was 502, 481, and 532 g/d, ADFI was 745, 711, and 743 g/d, and G:F was 673, 677, and 719 g/kg, respectively. Our results indicate that considerable mixing occurs as feed is moved from the feedmill mixer, through the feedmill, and during delivery to the pigs' feeder. Thus, a CV at the feedmill mixer may not be an accurate predictor of CV at the farm. Nonetheless, increasing mix time improved rate and efficiency of gain in nursery pigs with a CV at the feeder of 16% supporting better growth performance than a CV of 21%.

Key Words: nursery pigs, mix uniformity, growth performance

186 Effect of a novel β -mannanase and β -glucanase in corn-soybean meal-distillers dried grains with solubles diets on grower pig growth and feed efficiency. J. Ferrel^{*1}, B. Richert², D. Anderson¹, and D. Kelly², ¹ChemGen Corp, Gaithersburg, MD, ²Purdue University, West Lafayette, IN.

An experiment was conducted to determine the effect of adding β -1,4 mannanase and the potential additive response of a novel experimental β -1,3 glucanase, titrated at two levels, in a corn-soybean meal-distillers dried grains with solubles (DDGS) diet on pig growth, feed efficiency, and overall performance during the grower (BW = 18 to 70 kg) period. Two-hundred forty pigs (initial BW = 18.0 ± 0.16

kg) were allocated in a randomized complete block design of mixed gender pens, stratified by litter and initial BW, to five treatments, with 10 pens/treatment. Treatments were initiated at a block BW of 18 kg. Dietary treatments were: Positive Control (T1), Negative Control (T5) (T1 reduced by 112.5 kcal/kg, .02% TID Lys, .02% TID Thr), and the Negative Control diet plus enzymes for treatments T2 (mannanase, 0.11 MU/kg), T3 (T2 + 0.055 MU/kg glucanase), and T4 (T2 + 0.077 MU/kg glucanase). Pigs were fed three dietary phases, each three weeks in duration. Diets contained 15%, 20%, and 25% DDGS by phase, respectively. Individual BW and pen feed disappearance were recorded weekly. Assayed enzyme levels declined during storage of each dietary phase. Overall, pigs fed increasing levels of glucanase had increased ADG (linear, $P < 0.002$), final BW (linear, $P < 0.004$), and ADFI tended to increase (linear, $P < 0.06$) compared to T5. Pigs fed enzyme treated diets at the upper titration level (T4), showed improvement in overall ADFI ($P < 0.05$) and a numerical increase in overall ADG above T1 ($P < 0.17$). Overall G:F was improved for T1 compared to all other treatments ($P < 0.05$) while enzyme treatments were intermediate. Final BW for pigs fed T4 were 1.44 kg and 2.87 kg greater than T1 ($P < 0.18$) and T5 ($P < 0.004$), respectively. While additional work is needed to precisely define the response surface, these data clearly demonstrate the performance response to a novel β -mannanase in combination with a β -glucanase in the presence of high DDGS inclusion swine diets.

Key Words: β -mannanase, β -glucanase, swine growth

187 Metabolizable energy of various ingredients affected by carbohydrases. S. W. Kim*, C. M. Ballou, and Y. Zhao, *North Carolina State University, Raleigh.*

Fifty six barrows (36.6 ± 1.3 kg BW) were used to measure metabolizable energy (ME) of DDGS, copra meal, and palm kernel meal with or without carbohydrases (0.02%, Endopower β , Easybio Systems, Seoul, Korea). Corn was used as a basal diet and each ingredient replaced the basal diet by DDGS (40%), copra meal (20%), and palm kernel meal (20%) in test diets. There were 7 dietary treatments with 8 replicates per treatment group. Daily feed allowance was based on $0.09 \times \text{BW}^{0.75}$ divided into two equal amounts of meals fed at 0800 and 1700 h. Pigs were housed in metabolism cages for a 5-d adjustment period and a 4-d collection. Chromium oxide (0.5%) was used as an indicator of initiation and termination of fecal and urine sampling. Ingredients, diets, fecal samples, and urine samples were used to measure gross energy using a bomb calorimeter (IKA, Wilmington, NC). Ingredients, diets, and fecal samples were used to quantify soluble non-starch polysaccharide (SNSP) and insoluble non-starch polysaccharide (INSP) as described by AACC (32.11). The ME of each ingredient with or without carbohydrases was calculated using gross energy of the basal diet and test diets, ME of corn, and percentage of each ingredient replaced the basal diet. The ME of DDGS, copra meal, and palm kernel meal were 3837, 3376, and 3571 kcal/kg of DM, respectively. Inclusion of carbohydrases did not change ME of DDGS (3916 kcal/kg) and palm kernel meal (3715 kcal/kg). Inclusion of carbohydrases tended to increase ME of copra meal (3598 kcal/kg; 6.6% increase; $P = 0.089$). In fecal samples, percentages of SNSP and INSP contributed from copra meal (7.2 and 73.9%) were decreased ($P < 0.05$) when carbohydrases were included (6.2 and 67.0%) whereas SNSP and INSP of DDGS (4.8 and 69.8% vs. 3.8 and 67.7%) and palm kernel meal (5.1 and 74.2% vs. 4.8 and 69.4%) were not changed by inclusion of carbohydrases. Collectively, dietary supplementation of carbohydrases did not improve energy utilization of corn DDGS and

palm kernel meal, but tended to improve ME of copra meal potentially by improving the utilization of NSP.

Key Words: carbohydrases, metabolizable energy, pigs

188 Sow and litter response to supplemental dietary fat in lactation diets during high ambient temperatures. D. S. Rosero*¹, E. van Heugten¹, J. Odle¹, R. Cabrera¹, and R. D. Boyd², ¹North Carolina State University, Raleigh, ²Hanor Company, Inc., Franklin, KY.

The objective of this study was to determine the impact of supplemental dietary fat on total caloric intake and sow and litter performance during high ambient temperatures. Data were collected from 337 sows (PIC Camborough line) from July to September in a 2,600-sow commercial unit in Oklahoma. Diets were corn-soybean meal based with 7.5% dried distillers grains with solubles and 6.0% wheat middlings and contained 3.24 g standardized ileal digestible lysine/Mcal ME. Fat (animal-vegetable blend) was supplemented at 0, 2, 4, or 6%. Sows were balanced by parity, with 113, 109, and 115 sows representing parity 1, 2, and 3 to 7 (P3+), respectively. Feed disappearance (measured in a subset of 180 sows; 4.09, 4.18, 4.41, and 4.35 kg/d; $P = 0.05$) and caloric intake (13.3, 14.0, 15.2, and 15.4 Mcal/d; $P < 0.001$) increased linearly with increasing dietary fat. Parity 1 sows (3.95 kg/d) had lower ($P < 0.05$) feed disappearance than P2 (4.48 kg/d) and P3+ (4.35 kg/d) sows. Body weight change in P1 sows was greater ($P < 0.01$) than P2 or P3+ sows (-0.27 vs. 0 and 0.09 kg/d), whereas back fat loss was lower ($P < 0.02$) and loin depth gain was greater ($P < 0.001$) in P3+ sows compared to P1 and P2 sows. Litter weight gain was greater ($P < 0.02$) in P2 sows compared to P1 and P3+ sows (2.30 vs. 2.09 and 2.15 kg/d). Dietary fat improved litter weight gain (1.99, 2.14, 2.15, and 2.32 kg/d for 0, 2, 4, and 6% fat, respectively) in P3+ sows, but not in P1 or P2 sows (interaction, $P = 0.07$). Rectal and skin temperature and respiration rate of sows were greater ($P < 0.002$) when measured at wk 3 compared to wk 1 of lactation, but were not affected by fat supplementation. Parity 3+ sows had lower ($P = 0.02$) rectal temperature than P1 and P2 sows and respiration rate was lower ($P < 0.001$) in P1 sows compared to P2 and P3+ sows. In conclusion, caloric intake increased with the addition of fat from animal-vegetable blend because of effects on dietary energy density and feed intake. Increased caloric intake did not have beneficial effects on any measured criteria, except for improved litter gain in P3+ sows.

Key Words: fat, temperature, lactation

189 Effect of supplying an enzymatically hydrolyzed yeast and yeast culture product (EHY) containing mannan oligosaccharides to sow diets on reproductive responses. I. F. Hung*¹, M. D. Lindemann¹, G. L. Cromwell¹, and M. G. Holt², ¹University of Kentucky, Lexington, ²Vi-COR, Mason City, IA.

Yeast products have been reported to improve performance and gut health in animals and there are reports of dietary mannan oligosaccharide supplementation improving growth performance and immunity of weanling pigs and reproductive performance of sows. In this study, the effect of EHY (trade name Cel-Can) on performance of sows and their weaned pigs was examined. Sows ($n = 28$) with an average parity of 1.63 ± 0.92 were assigned to 2 dietary treatments: 1) a corn-soybean meal control diet or 2) the control diet with 0.2% EHY. The dietary treatments were started about d 101-102 of gestation

and continued throughout lactation. At weaning, litters from 7 sows on each diet (n = 104 total piglets) were split into nursery diets that also contained 0 or 0.2% EHY. With regard to sow performance, there were no differences in litter size and litter weight between control sows and EHY-fed sows ($P > 0.10$ at birth and weaning). However, piglet weight at birth and weaning from EHY-fed sows was heavier compared with those from control sows (1.65 vs. 1.47 kg, $P = 0.04$ and 6.95 vs. 6.17 kg, $P = 0.03$, respectively). Immunoglobulin levels (mg/mL) of colostrum and milk were numerically greater in EHY-fed sows than control sows (colostrum: IgG 57.9 vs. 51.5, IgA 12.3 vs. 11.2, IgM 3.8 vs. 3.7; late lactation milk (d 15 – 17): IgG 0.3 vs. 0.2, IgA 4.1 vs. 3.4, IgM 1.3 vs. 1.0), often in excess of 10% greater, but the results were not significant ($P = 0.13$ to 0.91). Piglets from EHY-fed sows were heavier throughout the 4-wk nursery period (Wk 0: 7.3 vs. 6.5 kg, $P = 0.007$; Wk 4: 19.7 vs. 17.8 kg, $P = 0.007$). While sow diet effects were observed in the nursery period, EHY supplementation during the nursery period had no effect on growth performance. In conclusion, in this study adding EHY to sow diets during the end of gestation and lactation increased both piglet birth and weaning weight, a difference that was further enhanced by the end of the nursery period.

Key Words: birth weight, sow, yeast

190 The effect of feeding sow colostrum on IgG absorption, intestinal morphology and expression of IgG receptor (FcRn) and β_2 -microglobulin in neonatal piglets. R. Cabrera*, X. Lin, A. Taro, M. Ashwell, A. Moeser, and J. Odle, *North Carolina State University, Raleigh.*

The transport of immunoglobulin G (IgG) across the epithelial barrier is achieved by the neonatal Fc receptor (FcRn) and this pathway provides passive immunity by delivering maternal immunoglobulin to the circulation of the neonate. The objective of this study was to determine the effect of time and feeding state on IgG absorption, intestinal morphology and expression of IgG receptors in the first 12 hours post-birth. Twenty newborn pigs were immediately fitted with umbilical arterial catheters and gavaged with 32 ml defatted colostrum per kg of body weight either at birth (0 h) or at 12 h post-birth under either fed (milk replacer) or fasted (saline solution) conditions (n = 5/group). A fifth reference group (n=5), was euthanized at birth. Blood samples were drawn at 0, 1, 2, 4, 8 and 12 h post-gavage. At 12 h post-gavage, pigs were euthanized and jejunum tissues were collected for intestinal morphology and expression of FcRn and β_2 M via RTPCR. Pig serum IgG was determined by radial immunodiffusion (RID). Data were analyzed according to a 2 × 2 factorial design (0 hour-fed, 0 hour-fasted, 12 hour-fed and 12 hour-fasted). There was no interaction between the time (age) of colostrum gavage (0 vs. 12 h) and nutritional state (fed vs. fasted) for any of the parameters nor were there any differences between fed and fasted pigs. Serum IgG increased progressively with time, reaching peak concentrations at 8 h post-gavage. Piglets given colostrum at 0 h had higher ($P < 0.05$) overall IgG absorption and higher ($P < 0.05$) villi height than those gavaged at 12 h post birth. Cycle thresholds (Ct) of FcRn and β_2 M were normalized to GAPDH as the housekeeping gene. Abundance of FcRn message was lower ($P = 0.019$) in pigs euthanized at birth compared with those gavaged at 0 h and killed at 12 h of age. There was no difference among the treatments in the expression of β_2 M. In conclusion, the highest IgG absorption was realized when the piglets were given defatted sow colostrum immediately after birth.

Key Words: neonatal swine, IgG, FcRn receptor

191 Changes in fetal and maternal tissues of gilts during gestation. Y. L. Ma*¹, M. D. Lindemann¹, G. C. Cromwell¹, and J. L. Pierce², ¹University of Kentucky, Lexington, ²Alltech Inc., Nicholasville, KY.

The objective of this study was to characterize changes in various fetal and maternal tissues of gilts during gestation. Crossbred gilts (n = 69) were selected at 183 ± 2.7 d and 137 ± 10 kg BW and allotted to receive Se (0.3 mg/kg diet) as Na selenite or organic Se (Sel-Plex; Alltech Inc., Nicholasville KY). Gilts were housed in gestation crates at 267 ± 5.7 d (171 ± 4 kg), estrus-synchronized, and bred. Gilts were then slaughtered at defined time points throughout gestation (d 0, 43, 58, 73, 91, 101, or 108 of gestation; n = 6 to 12 gilts/d). Total number of fetuses, crown-rump length, fetal weight, liver, and gastrointestinal (GI) tract weight were recorded. Placenta and uterine weights of the gilts were also recorded. Except for gestation BW gain of the gilts (40.3 vs. 36.2 kg for selenite and organic Se, respectively; $P < 0.05$), there were no other treatment differences ($P > 0.13$). Based on the pooled data, gestation BW gain of the gilts increased linearly (0, 25, 31, 43, 49, 53, 66 kg; $P < 0.01$) as gestation progressed. Both uterus weight (0.7, 2.4, 2.9, 3.5, 4.0, 4.7, 6.0 kg) and total placenta weight (0, 1.0, 2.2, 3.5, 3.5, 3.3, 4.4 kg) increased linearly ($P < 0.01$) during gestation. Fetal weight increased linearly and quadratically (0, 16, 105, 342, 734, 976, 1,360 g; $y = 0.2x^2 - 9.9x + 16.6$, $R^2 = 0.98$; where y = fetal weight (g) and x = d of gestation; $P < 0.01$). Fetal liver weight increased (0, -, 7.2, 17.1, 32.6, 33.4, 45.4 g; linear and quadratic, $P < 0.02$) as did GI tract weight (0, -, 3, 15, 41, 60, and 84 g; linear and quadratic, $P < 0.05$) during gestation (fetal liver and GI tract were not collected on d 43). Crown-rump length of the fetus also increased during gestation (0, 6.1, 12.4, 18.7, 23.8, 27.1, 30.8 cm; linear and quadratic: $P < 0.03$; $y = 0.0015x^2 + 0.13x - 0.40$, $R^2 = 0.99$). The results characterize the dynamic changes in fetal development that occur during gestation and indicate that Se source did not affect those changes.

Key Words: gestation, fetal development, selenium

192 Evaluation of potential sorting strategies on the lysine requirements of pigs. A Schinckel*¹, M Einstein¹, S Jungst², C Booher², T Stewart¹, and S Newman², ¹Purdue University, West Lafayette, IN, ²PIC North American, Hendersonville, TN.

A stochastic pig growth model was developed to reproduce the nonlinear relationships between birth, weaning and nursery-exit BW's to later grow-finish BW's, body composition, and lysine requirements. Six sorting strategies were evaluated: 1) sorting within sex at weaning, 2) sorting across sexes at weaning, 3) sorting within sex at movement from the nursery, 4) sorting across sexes at movement from the nursery, 5) sorting at 84-d of age within sex, and 6) sorting across sexes at 84-d of age. Alternative levels of sorting based on BW (50-50, 80-20, and 90-10 percentile) were evaluated. The daily lysine requirements were predicted for each sorted group of pigs. Grams of lysine in which each pig was over- or under-fed by feeding the mean predicted diet of the sorted group was evaluated from 84 to 168-d of age. Overall, the later the age of sorting, the greater ($P < 0.05$) the reduction in summed absolute values of each pig's daily lysine intake minus its daily lysine requirements. When fed to the mean requirement of the group, sorting at later ages produced groups of pigs, with reduced ($P < 0.05$) under- and overfeeding of lysine. Sorting into two 50-percentile groups based on BW at 55 or 84 d of age resulted in approximately the same precision of feeding as split sex feeding with no sorting based on BW. Sorting pigs into two 50-percentile groups was more effective in

producing pigs with different lysine requirements than sorting pigs in 80–20 or 90–10 percentile groups. The combined implementation of split-sex feeding and sorting based on BW resulted in the most precise feeding of pigs.

Key Words: pig growth, stochastic model, lysine requirements

193 Effects of increasing standardized ileal digestible lysine:calorie ratio on growth performance of growing-finishing pigs. J. R. Bergstrom*, N. W. Shelton, M. L. Potter, J. Y. Jacela, J. M. DeRouche, M. D. Tokach, S. S. Dritz, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan.*

A total of 1,080 pigs (PIC TR4 × 1050) were used in four 28-d RCB experiments to determine the lysine requirements of growing-finishing pigs reared in a new research facility. Low- and high-lysine diets without added fat were formulated for each experiment by varying amounts of corn, soybean meal, and synthetic amino acids in order to meet or exceed an ideal amino acid pattern. The 2 diets were blended to form 6 lysine levels. There were 6 pens with 6 or 8 pigs per pen and an equal number of barrows and gilts in each pen. In Exp. 1, 252 pigs (initially 37 kg) were fed standardized ileal digestible (SID) lys:cal ratios ranging from 2.09 to 3.59 g/Mcal ME. Performance and margin over feed cost (MOF) were optimal at 2.69 g/Mcal. In Exp. 2, 288 pigs (initially 56 kg) were fed SID lys:cal ratios ranging from 2.12 to 3.27 g/Mcal. Optimal performance and MOF occurred at 2.35 g/Mcal. In Exp. 3, 252 pigs (initially 80 kg) were fed SID lys:cal ratios ranging from 1.49 to 2.98 g/Mcal. Optimal performance and MOF occurred at 2.09 g/Mcal. In Exp. 4, 288 pigs (initially 102 kg) were fed the same SID lys:cal ratios as in Exp. 3. Increasing SID lys:cal ratio decreased (linear; $P < 0.04$) ADFI, carcass yield, and MOF, and improved (linear; $P < 0.01$) G/F. Despite a linear improvement in G/F, ADG did not improve above 1.79 g/Mcal, which resulted in the best MOF. These experiments agree with previous recommendations for pigs of this genotype. For pigs weighing 37 to 65 kg, 56 to 86 kg, 80 to 107 kg, and 102 to 129 kg, performance and MOF were optimized with SID lys:cal ratios of 2.69, 2.35, 2.09, and 1.79 g/Mcal ME.

Table 1.

	SID lys:ME, g/Mcal						SEM	Linear, Quadratic, $P <$ $P <$	
	2.09	2.39	2.69	2.99	3.29	3.59		$P <$	$P <$
Exp. 1	2.09	2.39	2.69	2.99	3.29	3.59			
ADG, g	982	993	1035	1018	1027	1025	16	0.04	0.15
G/F	0.40	0.41	0.43	0.42	0.43	0.44	0.01	0.01	-
Exp. 2	2.12	2.35	2.58	2.81	3.04	3.27			
ADG, g	1070	1103	1101	1088	1092	1065	17	-	0.12
G/F	0.35	0.36	0.36	0.36	0.37	0.37	0.01	0.02	-
Exp. 3	1.49	1.79	2.09	2.39	2.69	2.98			
ADG, g	890	899	972	939	918	969	27	0.06	-
G/F	0.30	0.30	0.32	0.31	0.32	0.33	0.01	0.01	-
Exp. 4	1.49	1.79	2.09	2.39	2.69	2.98			
ADG, g	959	1009	1009	1017	1018	1006	22	0.13	0.15
G/F	0.28	0.29	0.30	0.30	0.31	0.31	0.01	0.01	-

Key Words: finishing, lysine, pigs

194 Efficacy of methionine hydroxy analogue-calcium salt and DL-methionine to support nitrogen retention in growing pigs. F. O. Opapeju*¹, J. K. Htoo², and C. M. Nyachoti¹, ¹*University of Manitoba, Winnipeg, MB, Canada,* ²*Evonik Degussa GmbH, Hanau, Germany.*

Methionine is one of the limiting AA in swine diets. In addition to DL-methionine (DLM, 99% purity) and liquid DL-methionine hydroxy analogue-free acid (88%), calcium salt of methionine hydroxy analogue (MHA-Ca; 84%), is also commercially available as a Met source. Data on the efficacy of MHA-Ca relative to DLM in pigs are scarce. This study assessed the efficacy of MHA-Ca relative to DLM in growing pigs fed wheat-barley based diets using N retention as a response criterion. Fourty-two barrows (Genesus; average initial BW 19 kg) were used in two consecutive N-balance experiments with 21 pigs each. Pigs were randomly allotted to 7 test diets giving a total of 6 replicates per treatment. Dietary treatments consisted of a Met-deficient wheat-barley-based basal diet or the basal diet with 3 added levels of DLM (0.02, 0.04, and 0.06%) or MHA-Ca (0.0238, 0.0476, and 0.0714%), supplemented on an equi-molar basis. The basal diet was adequate in all nutrients and energy except for Met. Pigs were housed individually in metabolism crates and fed at 3.5% of their BW and had free access to water. After a 7-d adaptation period, feces and urine were collected quantitatively for 5 d. Although fecal N excretion was not different, urinary and total N outputs linearly decreased ($P < 0.05$) with DLM or MHA-Ca supplementation. Nitrogen retention, expressed as g/d, % of intake and % of absorbed, linearly increased ($P < 0.05$) with supplementation of DLM and MHA-Ca, indicating that efficacy was tested within the sensitive phase. The slope of DLM was higher ($P = 0.044$) than that of MHA-Ca when expressed as N retention (% of absorbed), however, the slopes were not different for N retention when expressed as g/d or as % of intake. Using a slope-ratio procedure, the relative efficacy of MHA-Ca to DLM observed in this experiment was 73.9, 71.2 and 56.3% on a weight to weight basis for N retained expressed as g/d, % of intake, and % of absorbed, respectively.

Key Words: efficacy, DL-methionine, methionine hydroxy analogue calcium salt

195 Interaction of dietary energy and protein on growth performance, carcass characteristics and feed digestibility in individually penned finishing barrows when fed at a constant lysine to calorie ratio. P. M. Cline*, T. C. Tsai, C. R. Dove, and M. J. Azain, *University of Georgia, Athens.*

Increasing the lysine to calorie (Lys:ME) ratio (g lysine/Mcal) in diets that meet the energy requirement for grower-finishing pigs has been shown to increase ADG. However, there is a lack of research on the effects of varying protein and energy at a constant Lys:ME ratio on growth performance. The objective of this study was to determine the performance response to changes in dietary fat, protein, and fiber content in finishing barrows while maintaining a constant Lys:ME ratio. This experiment was conducted in 2 trials of 25 individually penned pigs each (1 pig/pen, total 50 pigs). There were no trial interactions for the parameters measured therefore; data from both trials were combined. Barrows (initial wt=85.3kg) were blocked by weight and assigned one of five experimental diets (0.50, 0.55, 0.60, 0.65, and 0.70 % total lysine) with a constant Lys:ME ratio (1.833g lysine/Mcal). The 0.50% total lysine diet did not meet NRC requirements however, all other diets met requirements (NRC, 1998). Pigs were fed experimental diets for 28 d, and body weights, feed intakes, and ultrasound measurements were recorded on d 14 and 28. Blood samples were taken on d 28 to determine

serum urea nitrogen (SUN), insulin, T3, and T4. Digestibility of the diets were determined by the inclusion of 0.1% titanium dioxide as a marker in all diets and fecal grab samples were collected on d 14 and 28. ADG increased with increasing lysine (0.96, 1.13, 1.18, 1.29, 1.12 kg/d; L, Q, $P < 0.01$). Additionally, feed efficiency, caloric intake, and lysine intake increased linearly as lysine increased in the diet ($P < 0.01$). T3 increased linearly in pigs fed diets 0.50 to 0.70% lysine. Digestibility of energy, protein, NDF, and hemicellulose increased linearly in pigs fed 0.50 to 0.70% lysine. Formulating a diet to meet the NRC recommended Lys:ME ratio is not sufficient to ensure optimal growth. Therefore, the concentration of protein and energy of the diet must be evaluated and corrected to obtain optimal growth and efficiency.

Key Words: metabolizable energy, fat, protein

196 Effects of diet complexity and dietary fermented soy protein on growth performance and amino acids digestibility in weanling pigs. H. J. Kim*, X. Ao, J. P. Wang, J. H. Lee, and I. H. Kim, *Department of Animal Resource & Science, Dankook University, Cheonan, Choongnam, Korea.*

A total of 120 crossbred weanling pigs (5.68 ± 0.80 kg BW) were used to evaluate the effects of diet complexity and dietary fermented soy protein (FSP) on growth performance and amino acids digestibility in a 30 day study. Experimental diets consisted of simple (soybean meal as protein source) and complex (soybean meal, rice protein concentrate, potato protein concentrate and fish meal as protein sources) diets. Dietary treatments included: 1) simple diet; 2) simple diet with 5% FSP (replaced with soybean meal); 3) complex diet; 4) complex diet with 5% FSP. In treatment 2, FSP was added at the expense of soybean meal. Pigs were provided each experimental diet for 20 d (phase 1) and then fed the same common diet for 10 d (phase 2). During d 0-10, pigs fed FSP diet had greater ADG (246 g vs 232 g, $P < 0.05$) than those fed non-FSP diet. ADG in complex diet with FSP treatment was higher (249 g vs 224 g, $P < 0.05$) than in simple diet without FSP treatment. G:F in FSP treatments was significantly higher (0.747 vs 0.671, $P < 0.05$) than that in non-FSP treatments from d 0 to 10. Throughout the overall period, G:F was greater in FSP treatments (0.622 vs 0.589, $P < 0.05$) than that in non-FSP treatments. On d 10, N digestibility was higher in pigs fed the FSP diet (0.749 vs 0.706, $P < 0.05$) than those fed the non-FSP diet. Among the essential amino acids, digestibility of Lys was increased in pigs fed 5% FSP diet (0.825 vs 0.794, $P < 0.05$) compared with those fed non-FSP diet. Digestibility of total essential amino acids were higher in pigs fed the complex diet (0.748 vs 0.733, $P < 0.05$) than those fed the simple diet. Among the non essential amino acids, Ala digestibility in FSP treatments was greater 0.704 vs 0.679, $P < 0.05$) than that in non-FSP treatments. Total non-essential amino acids digestibility in pigs fed complex diets were higher (0.739 vs 0.710, $P < 0.05$) than those fed simple diets. In conclusion, these results indicated the feeding of 5% FSP to nursery pig improved feed efficiency and amino acids digestibility and diet complexity did not maximize the pig's growth performance in the subsequent phase.

Key Words: amino acids digestibility, fermented soy protein, pigs

197 Effect of graded levels of corn distillers dried grains with solubles (DDGS) on growth performance of nursery pigs. T.-C. Tsai*¹, R. Dove¹, P. Cline¹, A. Owusu-Asiedu², and M. Azain¹, ¹*University of Georgia, Athens, Georgia,* ²*Danisco Animal Nutrition, Marlborough, UK.*

The objective of this study was to evaluate the effect of corn DDGS (DDGS) in phase 2 and 3 starter diets. A total 160 pigs (Initial BW ave. 6.0 ± 0.5 kg) were randomly selected for two 35 d trials, and were housed in environmentally controlled room. After weaning (d 21), pigs were fed a common phase 1 diet from d 0-7 post-weaning. On d 7, they were assigned to one of four treatments: 0, 10%, 20%, and 30% DDGS replacing corn and SBM. Corn DDGS used in this study had ME:3.39kcal/g, CP: 27.64%, Fat: 10.54%. Pigs were fed phase 2 diets (ME:3.3 kcal/g, 1.4% lysine, 0.8% Ca, 0.4% aP) from d 7-21 and phase 3 diets (ME: 3.4 kcal/g, 1.25% lysine, 0.75% Ca, 0.35% aP) from d 21-35. All diets were formulated to be isocaloric and isonitrogenous and fed in mash form. There was no significant difference in overall ADG, ADFI, and G:F ratio between the 2 trials. In phase 2, there was a trend ($P = 0.06$) for a linear decrease in gain with increasing DDGS, but this was primarily due to the decreased ADG in pigs fed the 30% diet. ADFI was increased linearly as DDGS increased ($P < 0.05$) and G:F was decreased ($P < 0.01$). In phase 3, pigs fed 20%, and 30% DDGS had reduced ADG relative to the control diet (Linear, $P < 0.01$). ADFI was not different between groups ($P > 0.20$). G:F was linearly decreased as DDGS increased ($P < 0.01$). Overall, feeding 30% DDGS in phase 2 and 3 reduced ADG (416, 415, 398, 361 g/d for 0, 10, 20 and 30% DDGS respectively; $P < 0.01$) and G:F (0.614, 0.590, 0.556 and 0.512; $P < 0.01$), but had no effect on ADFI. At 10% in the phase 2 and 3 diet, there was no significant effect of DDGS on performance. At 20% of the phase 2 and 3 nursery diet, DDGS feeding resulted in a 4% reduction in ADG and a 9% reduction in G:F. The results suggest that addition of 10% DDGS in starter diets had no negative impact on growth performance when fed 7-35 days post-weaning.

Key Words: nursery pigs, DDGS

198 Effects of corn DDGS and Allzyme SSF supplementation on performance and fat characteristics of grow-finish pigs. G. Li¹, W. Yao¹, and K. Filer*², ¹*Nanjing Agricultural University, Nanjing, China,* ²*Alltech Inc., Nicholasville, KY.*

The trial investigated effects of dried corn distillers grains with solubles (DDGS) and a solid state fermentation product (Allzyme SSF, Alltech Inc.) in 200 grow-finish pigs (Duroc \times Landrace \times Yorkshire) aged 70 d with average initial BW 28.75 kg. Pigs were randomly allotted to 4 treatments based on BW and sex, with 5 pens/treatment and 10 pigs/pen. Treatments were: Control: basal corn-soy diet; T1: corn-soy-DDGS diet (10 and 15% DDGS in grow and finish phases, respectively); T2: T1 + 0.2 g/kg SSF; T3: T1 with energy reduced by 50 kcal/kg + 0.2 g SSF/kg. Energy reduction was accomplished with reduced corn/soy and increased wheat bran. Measurements included average daily gain (ADG), feed intake (ADFI) and feed:gain (F:G). Intramuscular fat (IMF) content, iodine value (IV), fat melting point and fatty acid (FA) composition were evaluated using 5 pigs/trt. All treatments had similar ADG (681.15, 671.99, 709.28, 700.29 g/d) ($P = 0.471$), ADFI (2.00, 2.02, 2.04, 2.10 kg/d) ($P = 0.484$) and F:G (2.94, 3.01, 2.88, 2.30) ($P = 0.245$). IM fat content decreased with DDGS inclusion: longissimus dorsi: 2.69, 2.24, 2.16, and 2.17% for control, T1, T2, and T3, respectively ($P = 0.024$); psoas major: 1.72, 1.33, 1.41, and 1.22% for control, T1, T2, and T3, respectively ($P < 0.001$). Fat IV increased with dietary

DDGS inclusion: backfat (61.05, 64.62, 64.99, 65.58) ($P = 0.035$); belly fat (59.92, 62.72, 63.09, 62.86) ($P = 0.003$). Dietary DDGS reduced fat melting point (backfat: 48.16, 47.33, 46.98, 46.76 °C, $P = 0.002$; belly fat: 48.52, 47.64, 47.43, 47.96 °C, $P = 0.010$). Feeding DDGS increased unsaturated FA content in backfat and longissimus dorsi, especially oleic and linoleic acids ($P < 0.05$), while saturated FA decreased ($P < 0.05$). Decreasing energy produced the highest unsaturated FA content in tissues. In conclusion, DDGS inclusion had no detrimental effect on performance and SSF numerically improved performance vs. the SSF-free diet. DDGS increased fat IV and reduced melting point and IM fat, which was not compensated with SSF. Feeding corn DDGS increased unsaturated FA and decreased saturated FA in backfat and longissimus dorsi.

Key Words: distillers dried grains, fat composition, enzyme

199 Effects of sulfur concentration in distillers dried grains with solubles on feed preference and pig performance. B. G. Kim^{*1}, Y. Zhang², and H. H. Stein¹, ¹University of Illinois, Urbana, ²National Corn-to-Ethanol Research Center, Edwardsville, IL.

Four experiments were conducted to examine the effects of dietary S levels on feed palatability and performance of weanling and grow-finishing barrows. In a 10-d feed preference test (Exp. 1), 48 pigs (20.1 kg) were grouped into 8 blocks and allotted to 3 treatments with 2 pigs/pen. A corn-soybean meal control diet (CON) and a diet containing corn, soybean meal, and 20% distillers dried grains with solubles (DDGS) were prepared. A third diet (DDGS+S) was similar to the DDGS diet with the exception that S from calcium sulfate was added to mimic DDGS with 0.9% S. Two diets were provided in each pen. The feed preference for the DDGS diet and the DDGS+S diet vs. CON was 35.2 and 32.6%, respectively ($P < 0.05$). However, feed preference was unaffected by the concentration of S in the DDGS-containing diets. In a 28-d feeding trial (Exp. 2), 90 pigs (10.3 kg) were allotted to 3 treatments, 10 blocks, and 3 pigs/pen. The same diets as in Exp. 1 were used. Pigs fed the CON diet had greater ($P < 0.05$) ADG (497 vs. 423 and 416 g/d) and G:F (0.540 vs. 0.471 and 0.455) compared with pigs fed the DDGS and the DDGS+S diets. Exp. 3 was also a preference test and used 30 individually housed pigs (49.6 kg). Diets were similar as in Exp. 1 except that DDGS was included at 30% in the 2 DDGS-containing diets. The preference for the DDGS diet and the DDGS+S diet compared with CON was 29.8 and 32.9%, respectively ($P < 0.001$). However, the preference was unaffected by the concentration of S in the DDGS-containing diets. In an 84-d feeding trial (Exp. 4) with 120 pigs (34.2 kg), the design was the same as in Exp. 2, but 30% DDGS was used in the DDGS-containing diets. Pigs fed the CON diet had greater ($P < 0.05$) ADG (1,021 vs. 912 and 907 g) and G:F (0.335 vs. 0.316 and 0.307) than pigs fed the DDGS and the DDGS+S diets. In conclusion, inclusion of 20 to 30% of DDGS in diets fed to weanling and grow-finishing pigs reduced palatability of the diets and negatively affected growth performance. However, the concentration of S in the DDGS-containing diets had no impact on feed palatability or growth performance.

Key Words: distillers dried grains with solubles, feed preference, sulfur

200 Concentrations of analyzed or reactive lysine, but not crude protein, may predict the concentration of digestible lysine in distillers dried grains with solubles fed to pigs. B. G. Kim^{*1}, Y. Zhang², and H. H. Stein¹, ¹University of Illinois, Urbana, ²National Corn-to-Ethanol Research Center, Edwardsville, IL.

The objective of this experiment was to investigate procedures that may be used to predict the concentration of standardized ileal digestible (SID) Lys in distillers dried grains with solubles (DDGS) fed to pigs. Twenty-one sources of DDGS were analyzed for CP (23.8 to 33.6%; CV = 8.3%), Lys (0.69 to 1.17%; CV = 12.4%), and furosine (0.02 to 0.22%; CV = 91.4%) on an as-fed basis. The concentration of reactive Lys (%), calculated as analyzed Lys (%) – furosine (%) $\times 0.40 \div 0.32$, ranged from 0.47 to 1.15% (CV = 20.7%) in the 21 sources of DDGS. Twenty-one diets that each contained 60% of 1 source of DDGS as the sole source of CP and AA were formulated. An N-free diet was also formulated and used to measure basal endogenous losses of CP and AA. Twenty-two barrows with an initial BW of 45.2 kg (SD = 3.14) were used. Pigs were fitted with a T-cannula in the distal ileum and allotted to a 22 \times 10 Youden square design with the 22 diets and 10 periods. The SID of CP and AA were calculated for each diet. The SID of CP ranged from 69.8 to 79.6%, and the SID of Lys from 45.3 to 74.1%. The concentration of SID Lys in the DDGS sources was highly correlated with the concentration of analyzed Lys (SID Lys, % = $-0.482 + 1.148 \times$ analyzed Lys, %; $P < 0.001$, $r^2 = 0.849$) and with the concentration of reactive Lys in the samples (SID Lys, % = $-0.016 + 0.716 \times$ reactive Lys, %; $P < 0.001$, $r^2 = 0.898$). However, the concentration of SID Lys in the DDGS sources was not correlated with the concentration of CP in the samples ($P = 0.558$, $r^2 = 0.021$). In conclusion, the analyzed Lys, but not CP, may be used to predict the concentration of SID Lys in DDGS fed to pigs. The analysis of furosine in addition to Lys and subsequent calculation of reactive Lys may slightly improve the prediction accuracy of the digestible Lys concentration in DDGS.

Key Words: distillers dried grains with solubles, furosine, lysine digestibility

201 Effect of particle size of corn distillers dried grains with solubles (DDGS) on digestible and metabolizable energy content for growing pigs. O. F. Mendoza^{*1}, M. Ellis¹, A. M. Gaines², M. Kocher², T. Sauber³, and D. Jones³, ¹University of Illinois, Urbana, ²The Maschhoffs, Carlyle, IL, ³Pioneer Hi-Bred, Johnston, IA.

The objective was to determine the effect of particle size on the energy digestibility of 15 sources of corn DDGS using growing barrows (17.2 \pm 0.9 kg BW; n = 31). Two particle sizes were evaluated for each source: As-Received (mean particle size 716 \pm 264 μ m) and Finely Ground (344 \pm 36 μ m). A corn-based diet (89.5% corn supplemented with 8.0% sodium caseinate, 1.0% limestone, 0.65% dicalcium phosphate, and 0.85% minerals and vitamins) and 30 experimental diets (15 sources by 2 particle sizes) were used with 50.4% of the corn replaced with each sample of corn DDGS. An incomplete block design (block = group of 31 crates) was used with the corn and each corn DDGS diet being fed to 36 and 8 pigs, respectively, over a 4-d adaptation period followed by a 3-d collection period during which the total but separate collection of feces and urine was carried out. Gross energy of diets, feces and urine was determined by bomb calorimetry. The energy values for the corn were 3,891 \pm 71.4 kcal DE/kg DM and 3,804 \pm 75.0 kcal ME/kg DM. The DE and ME content of the corn DDGS sources were determined by the difference method. Dry matter digestibility (86.8 vs. 89.1%; SEM

0.46; $P < 0.001$), energy digestibility (81.8 vs. 85.3%; SEM 0.55; $P < 0.001$), DE (3,593 vs. 3,748 kcal/kg DM; SEM 24.2; $P < 0.001$), and ME (3,302 vs. 3,470 kcal/kg DM; SEM 31.4; $P < 0.001$) were increased for the Finely Ground compared to the As-Received particle sizes. These results show that there is considerable variation in particle size among commercial corn DDGS sources and that the DE and ME content of corn DDGS can be improved by grinding to a lower particle size.

Key Words: DDGS, particle size, energy

202 Impact of dietary inclusion of distillers dried grains with solubles (DDGS) and conjugated linoleic acid (CLA) on pig growth performance, carcass characteristics, and meat and fat quality. L. Ochoa*¹, M. Ellis¹, J. Eggert², B. Cousins³, A.M. Gaines⁴, and F.K. McKeith¹, ¹University of Illinois, Urbana, ²Newsham Choice Genetics, West Des Moines, IA, ³BASF Co., Florham Park, NJ, ⁴The Maschhoffs, Carlyle, IL.

The impact of feeding CLA and DDGS on growth performance, carcass characteristics, and meat and fat quality in finishing pigs was evaluated in a 56-d study (~80 to 135 kg BW) that was divided into two 28-d periods. A RCBD (block = start date) was used for both periods; Period I used 120 barrows in pens of 4 and compared 2 levels of DDGS (0 and 30%); Period II had a 2 × 3 factorial arrangement of treatments: 1) DDGS inclusion level (0 vs. 30%) and 2) CLA inclusion level (0 vs. 0.5 vs. 1.0%). In Period II, 90 pigs from Period I were re-allotted within DDGS level to pens of 3 that were randomly allotted to CLA level. Pigs were harvested at the end of Period II and carcass and pork quality measurements taken. For Period I, there was no effect ($P < 0.05$) of DDGS level on growth performance and carcass characteristics. For Period II, there were no DDGS × CLA interactions ($P > 0.05$) and no effect ($P > 0.05$) of either treatment on growth performance. Feeding 30 compared to 0% DDGS reduced ($P < 0.05$) belly flop distance (15.1 vs. 32.4 cm; SEM 1.16), and increased ($P < 0.05$) the amount of polyunsaturated fatty acid (23.7 vs. 16.2%; SEM 1.34) and the iodine value (76.4 vs. 67.7; SEM 2.13) of backfat. Feeding CLA at 0.5 and 1.0 vs. 0, 0.5, and 1.0% CLA, respectively; SEM 0.47) and reduced ($P < 0.05$) belly weights (5.08 vs. 4.65 vs. 4.63 kg, respectively; SEM 0.112) but increased ($P < 0.05$) belly flop distance at the 1.0% level only (21.4 vs. 22.6 vs. 27.2 cm, respectively; SEM 1.42) without affecting ($P > 0.05$) the iodine value of the backfat (73.0 vs. 72.3 vs. 70.2, respectively; SEM 1.28). The results of this study suggest that including CLA at 1.0% of the diet can remediate soft belly problems associated with feeding of DDGS.

Key Words: DDGS, CLA, growth performance

203 Effects of a high protein distillers dried grain (HPDDG) product on growth performance and carcass and pork quality characteristics of wean-to-market pigs. C. L. Puls*¹, M. Ellis¹, A. M. Gaines², B. A. Peterson², B. F. Wolter², R. Bowman², and M. Kocher², ¹University of Illinois, Urbana, ²The Maschhoffs, Carlyle, IL.

The effects of HPDDG on growth performance of pigs and on carcass and pork quality characteristics from weaning (6.3 ± 0.30 kg) to market BW (124.6 ± 1.89 kg) were evaluated. A RCBD was used with 1 treatment (HPDDG inclusion level) and 5 levels [0, 10, 20, and 30% HPDDG and a positive control (0% HPDDG, isocaloric to the 30% HPDDG level

diet)]. Diets were formulated to meet or exceed NRC (1998) recommendations for nutrient requirements. A total of 1,836 pigs housed in mixed-gender pens (barrows and gilts) of 34 were used in 9 replicates. Pigs were weighed at the start and end of the study; all feed additions were recorded. At the end of the study, pigs were harvested at a commercial plant, carcass measures taken, and belly fat samples obtained. There was no effect ($P > 0.05$) of HPDDG inclusion level up to 20% on growth performance or carcass measures. Compared to the control, pigs fed diets with 30% HPDDG had lower ($P < 0.05$) ADG (0.73 vs. 0.63 kg for control and 30% HPDDG, respectively; SEM 0.006), ADFI (1.80 vs. 1.66 kg; SEM 0.013), and G:F (0.404 vs. 0.382; SEM 0.0024), higher morbidity and mortality (7.5 vs. 14.1%), and lower HCW (93.4 vs. 91.0 kg; SEM 0.45), carcass yield (75.0 vs. 73.1%; SEM 0.36), and LM depth (6.06 vs. 5.74 cm; SEM 0.064). The negative and positive control treatments had similar ($P > 0.05$) growth, carcass, and meat quality characteristics. The proportion of saturated fatty acids in the belly fat decreased ($P < 0.05$) and the proportion of unsaturated fatty acids and the iodine value (60.0 vs. 62.1 vs. 64.8 vs. 68.8 vs. 66.7 for 0, 10, 20, and 30% HPDDG and positive control, respectively; SEM 1.25) increased ($P < 0.05$) with increasing HPDDG inclusion level. The results of this study suggest that HPDDG can be included in diets for wean-to-market pigs at up to 20% of without any negative effect on growth performance; however, the negative effects of 30% HPDDG inclusion are of concern and merit further study.

Key Words: pigs, growth, high protein DDG

204 Dried distillers grains with solubles (DDGS) at 20% dietary inclusion do not inhibit growth performance or carcass characteristics when fed with or without a Paylean™ program or CLA. J.W. Rickard*, D. Pompeu, B.R. Wiegand, G.D. Gerlemann, R.B. Hinson, and G.L. Allee, University of Missouri, Columbia.

This study evaluated the effects of the inclusion of dried distillers grains with solubles (DDGS), conjugated linoleic acid (CLA) and ractopamine (RAC) on growth performance and carcass characteristics of heavy market hogs. All protocols were performed according to University of Missouri ACUC Guidelines. Barrows (n=72) of PIC 337 × C22 genetics were blocked by weight and assigned randomly within a 2 × 2 × 2 factorial arrangement yielding a CRBD with 9 replications per treatment. Factors included DDGS (0 or 20%), CLA (0 or 0.6%), and RAC (0 or 7.4 ppm). Pigs were individually fed for 28 d before slaughter and pig was the experimental unit. Pigs (136 ± 8 kg) were humanely slaughtered. Pigs fed RAC had increased final weights ($P = 0.01$) (138.9 vs. 134.2 kg) and ADG ($P = 0.0001$) (1.35 vs. 1.18 kg/d). Inclusion of DDGS did not alter G:F ($P = 0.92$), however G:F improved with the inclusion of RAC ($P = 0.0001$) (0.39 vs. 0.34) and the inclusion of CLA ($P = 0.016$) (0.38 vs. 0.35). Dietary inclusion of DDGS decreased ADFI ($P = 0.04$) (3.37 vs. 3.55 kg/d). Dietary RAC increased HCW ($P = 0.0002$) and LEA ($P = 0.0003$) (52.8 cm² vs. 47.7 cm²). Lower 10th Rib Fat measurements were observed with RAC ($P = 0.005$) (2.35 cm vs. 2.67 cm) and CLA ($P = 0.01$) (2.34 cm vs. 2.68 cm), but not with DDGS ($P = 0.10$). Wholesale belly weight was greater for RAC ($P = 0.05$) (8.37 kg vs. 8.03 kg). Belly weight tended ($P = 0.09$) to be lighter for DDGS (8.05 kg vs. 8.35 kg). Loin pH at 24h was higher in pigs supplemented with RAC ($P = 0.001$). Subjective quality parameters were not significantly different based on treatment with the exception of subjective firmness, which decreased with RAC addition ($P = 0.03$). Minolta a* value decreased slightly ($P = 0.01$) with RAC (14.82 vs. 15.32). Minolta fat color values (L*, a, b*) were not changed with DDGS, RAC or CLA. No significant interactions

were observed. The results indicate that DDGS (20% inclusion) do not alter growth performance or carcass parameters in heavy market hogs. Furthermore, RAC and CLA can improve specific measures of growth performance and carcass fatness.

Key Words: pork, DDGS, CLA

205 Assessment of protein quality in a corn co-product based on growth of young pigs. J. R. Booth*, J. L. Reichert, and T. D. Crenshaw, *University of Wisconsin, Madison.*

Increased ingredient prices have re-kindled interest in assessment of alternatives to economically meet pig requirements. Ethanol co-products offer new alternatives, but may be of limited value for swine. A new ingredient with potential value for swine is Hi-Pro Meal (HPM) produced by Badger State Ethanol (Monroe, WI). By analysis HPM contains 51.7% CP, 2.5% fat, 2.6% Lys and 0.43% Trp. The low fat is advantageous as fat content limits inclusion rate for some corn co-products. A 26-d growth assay was used to establish a maximum inclusion of HPM in corn-based diets for growing pigs and to determine if Lys and Trp were first and second limiting. A corn-SBM control diet (Ctl, diet 1) was formulated to meet 105% of Lys requirement. Diets 2, 3, and 4 were formulated with 10%, 20%, and 30% HPM respectively to supply 95% of Lys requirements. Diets 5 and 6 both included 30% HPM but additional Lys (diet 5 to supply 110% of required Lys) or Lys + Trp (diet 6 to supply 110% of required Lys and 130% of required Trp) added to assess the order of limiting amino acids. Crossbred (PIC Cambrough × Line 19) pigs (n=144) were randomly allotted to 1 of 6 diets within weight and sex blocks at approximately 45 d of age. Pigs were housed with 4 pigs in 1.52 × 0.91 m pens. Pigs were allowed continuous access to feed and water. Pigs fed the Ctl diet had higher ADG and improved feed efficiency compared with pigs fed HPM regardless of HPM level or amino acid supplementation. Growth was suppressed as HPM levels increased. Addition of Lys improved ADG and efficiency, but further addition of Trp failed to improve performance. In conclusion, protein quality of HPM can be improved by additional Lys, but Trp does not appear to be second limiting. Other factors affecting protein quality need to be evaluated.

Table 1. Dietary treatments

Trait	1	2	3	4	5	6	SEM
ADG, kg/d ^{abc}	0.70	0.62	0.52	0.44	0.53	0.53	0.02
FI, kg/d ^{ab}	1.20	1.16	1.04	0.98	1.04	1.05	0.04
Feed:Gain ^{abc}	1.70	1.86	2.01	2.22	1.97	1.99	0.04

^aCtl vs HPM, $P < 0.01$; ^bHPM level linear, $P < 0.01$; ^c4 vs 5,6, $P < 0.01$.

Key Words: bioassay, protein quality, co-products

206 Concentrations of β-glucans and mannan oligosaccharides in corn dried distillers grains with solubles (DDGS) and its relationship to fiber components. J. M. Pomeroy*, L. W. O. Souza, and G. C. Shurson, *University of Minnesota, St. Paul.*

Typically, β-glucans (BG) and mannan oligosaccharides (MOS) can be found in the bran of cereal grains, yeast cell walls, plant cellulose, and in many types of fungi and bacteria. Furthermore, both BG and MOS are known to exhibit beneficial health properties. The objective

of this study was to determine the concentrations of BG and MOS in corn dried distillers grains with solubles (DDGS) containing varying levels of ADF and NDF, and to determine if any correlation between fiber content and BG content existed. Thirty-four samples of DDGS from various dry-grind ethanol plants in the Midwest were selected based on their varying concentrations of ADF and NDF. Both ADF and NDF concentrations were previously determined using wet chemistry procedures from commercial laboratories. Samples of DDGS contained between 7.21% to 17.27% ADF, while NDF content ranged from 20.13% to 32.94%. Average concentration of ADF and NDF was 10.68% and 25.35%, respectively. Samples were prepared in duplicates, and enzymatic kits (K-YBGL 04/2008 and K-MANGL 01/05) from Megazyme (Megazyme International Ireland Limited, Bray, Ireland) were used to determine BG and MOS content. Data were analyzed utilizing the Univariate and Corr procedures of SAS. The content of BG ranged from 5.51 g/100 g to 10.09 g/100g. Average BG content in DDGS samples was 7.61 g/100g. Concentration of BG and ADF were positively correlated ($P < 0.006$) with a Pearson correlation coefficient of 0.46. Conversely, NDF and BG were not correlated ($P > 0.5$). Unfortunately, MOS concentrations were below detectable levels. Overall, these results indicate that BG concentration in DDGS is positively correlated to the ADF fraction. Furthermore, the level of BG in DDGS is variable, yet is relatively higher in comparison to other feed ingredients such as oats or barley.

Key Words: dried distillers grains with solubles, β-glucans, mannan-oligosaccharides

207 Effect of a commercial enzyme (Nutrase) on growth performance of growing pigs fed diets containing dried distillers grains with solubles (DDGS). J. Y. Jacela*, S. S. Dritz, J. M. DeRouchey, M. D. Tokach, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan.*

A total of 1,076 pigs (PIC BW=39.7 kg), were used to determine the effect of a commercial enzyme containing bacterial endo-1,4-beta-xylanase (Nutrase; Nutrex, Lille, Belgium) on the growth performance of pigs fed diets with DDGS. Pigs were randomly allotted to 1 of 3 treatments (13 pens/trt) balanced by initial BW within gender. Treatments were: 1) diet with 3% added fat (Control); 2) diet supplemented with enzyme (Nutrase) with 1.9% added fat but formulated to have an energy content equal to that of the control diet based on calculated increased ME from the enzyme; and 3) diet with 1.9% added fat without enzyme formulated using the same energy values for the control diet (Low energy). Diets were corn-SBM-based containing DDGS fed in 3 phases from 39 to 95 kg BW. Corn and SBM ME values were based on NRC (1998) while ME used for DDGS was equal to corn. Diets contained 30% DDGS in phases 1 & 2 (39 to 59kg and 59 to 84 kg, respectively) and 15% DDGS in phase 3 (84 to 95kg). Within each phase, all diets had the same lysine levels. Thus, Control and Nutrase diets had lys:ME ratios of 2.69, 2.29, and 1.97 g/Mcal ME for phases 1, 2, and 3; respectively, while the low energy treatment had lys:ME ratios of 2.73, 2.32, and 2.00 g/Mcal ME for phases 1, 2, and 3, respectively. There was no treatment × gender interactions ($P > 0.25$) observed for any response criteria. Barrows had greater ($P < 0.01$) ADG (844 vs 795 g), ADFI (2.21 vs 2.01 kg), and final BW (97.0 vs 92.9 kg) but poorer G:F ($P < 0.01$; 0.38 vs 0.40) compared to gilts. Overall, there were no differences between Low energy, Control, and Nutrase treatments for ADG ($P = 0.86$; 825, 817, and 817g), ADFI ($P = 0.93$; 2.12, 2.10, and 2.11 kg), G:F ($P = 0.65$; 0.39, 0.39, and 0.39)

and final BW ($P = 0.88$; 95.1; 95.4; and 94.4 kg). In conclusion, under the conditions of this experiment, the commercial enzyme used at the manufacturer's recommended level did not affect growth performance of growing pigs fed diets containing DDGS.

Key Words: DDGS, enzyme, pig

208 Solid state fermentation-derived enzymes improve energy and nutrient digestibility in pigs under good management.

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The effect of solid state fermentation enzymes (SSF) on energy and nutrient digestibility in pigs under good management conditions was investigated in the grow-finish phase. Twelve weaned castrates were assigned to a wheat and barley-based control diet and to a SSF (Allzyme SSF, Alltech Inc.)-supplemented test diet (200 ppm SSF) in a Latin Square Design and fed restricted over 14 wks. Both diets were extruded before supplementation to inactivate natural phytase then pelleted after SSF addition. Phytase activity of feeds was determined before and after extrusion and pelleting. Digestibility of dietary energy, protein, phosphorus and total minerals were evaluated by an indicator method at four collection periods, evenly distributed in growing and finishing periods. Natural phytase activity of the feed (0.742 PU/g) was reduced by 50% due to extrusion (90°C, 5 bars) while pelleting (55–60°C) reduced the activity of supplemental phytase by 22%. Phytase activity of the control and test feeds after pelleting were 0.308 and 0.368 PU/g, respectively. Apparent total-tract digestibility of energy, protein and phosphorus with the control feed for the whole trial period were 0.83, 0.80, and 0.34, respectively. SSF supplementation increased the total-tract digestibility of dietary energy by 5%, protein by 9.3%, phosphorus by 53.6% and total minerals by 28.1% ($P \leq 0.001$) during the growing phase. However, none of the parameters were improved by SSF during the finishing phase. Therefore, when the digestibility values were calculated for the entire fattening period, the improvements (relative to the control) were rather low (1.3%, 3.4%, 11.8% and 8.3%, respectively). The digestibility of energy and protein were improved by 3.7 and 9.0% ($P \leq 0.05$), respectively, with pig age irrespective of diet. Phosphorus and total mineral digestibilities were also generally improved by 2.8 and 5.6%, respectively, with age. It is concluded that SSF enzymes improve the digestibility of dietary energy, protein, phosphorus and total minerals in growing pigs even under good management conditions. Phytase in SSF tolerates pelleting temperatures from 55–60°C.

Key Words: enzyme, phytase, digestibility

209 Alternative strategies in providing digestible protein to young piglets: yeast-derived protein (NuPro) plus enzymes from solid state fermentation (Allzyme SSF).

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Soybean meal (SBM) combined with dried whey and plasma protein are typically used protein sources in post-weaning diets. This experiment investigated whether yeast protein with added enzyme can replace plasma and dried whey in diets for newly weaned pigs. A total

of 630 piglets (6.8 kg BW) were randomly allotted to 18 equal groups (35 pigs/pen). Six pens were randomly assigned to each of 3 dietary treatments in a 2-phase feeding program (0 to 21 days: Phase 1, 22 to 49 days: Phase 2). Trt 1 in both phases contained low levels of SBM (18%), and high levels of dried whey (15 and 10% in phases 1 and 2), and plasma protein (5%). Trt 2 contained 25% SBM, moderate levels of dried whey (5 and 2.5% in phases 1 and 2), no plasma protein, and moderate levels of yeast-derived protein (NuPro, Alltech Inc., 3 and 2% in phases 1 and 2). Trt 3 in both phases contained high levels of SBM (25%), no dried whey, no plasma, and high levels of NuPro (4 and 3% in phases 1 and 2). Trts 2 and 3 were supplemented with a solid state fermentation product (Allzyme SSF, Alltech Inc., 0.02%). Feed intake (FI), BW gain, average daily gain (ADG), feed conversion ratio, and survival rate were recorded. Fecal consistency was measured at 7, 14 and 21d. Intestinal samples were taken from one pig per pen at 7 and 28d to measure duodenal villus height and crypt depth using light microscopy. Data were subjected to ANOVA. Phase 1 FI was highest for Trt 1 compared with Trt 2 (NS) or 3 (406, 378, 339 g/d; $P = 0.02$). Phase 1 survival rate was lower for Trt 3 compared with Trts 1 or 2 (0.0, 0.1 and 2.9% for Trts 1, 2 and 3; $P < 0.03$). Fecal score (1–4: 1 = solid, 4 = loose) was highest at 7d (phase 1) for pigs in Trt 3 (2.4, 2.4, 3.0; $P = 0.03$). No differences in the other growth and scouring parameters were noted in phase 2 or overall. Crypt depth at 7d was numerically higher for Trt 1 and highest for Trt 3 at 28 d. This study demonstrates that the combination of NuPro and Allzyme SSF can successfully replace plasma and whey powder for newly weaned pigs, which offers opportunities for cost savings.

Key Words: digestible protein, morphology, yeast

210 Effects of supplementation mannanase and xylanase of low energy density diet on growth performance, nutrient digestibility, blood profiles and meat quality in finishing pigs.

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This study was conducted to investigate the effects of supplementation mannanase and xylanase on growth performance, nutrient digestibility, blood profiles and meat quality in finishing pigs. A total of 96 pigs (69.12 kg, average initial body weight) were used during 8 weeks. Dietary treatments included: 1) CON (basal diet), 2) LC (–150kcal/kg low energy density diet), 3) LM (LC + 0.05% mannanase), and 4) LMX (LC + 0.05% mannanase and xylanase complex). Each treatment had 6 replicates of 4 pigs per pen in a randomized complete block design. ADG was higher ($P < 0.05$) in LMX treatment than LC and LM treatments when the entire period was evaluated. LM treatment was higher than LMX treatment in ADFI ($P < 0.05$), with gain/feed was highest in LMX treatment ($P < 0.05$). Energy digestibility in week 4 and N digestibility in week 8 were higher ($P < 0.05$) in LMX treatment than LC treatment. Glucose concentration in blood in week 8 was higher in LMX treatment than LC treatment ($P < 0.05$). In meat color, brightness (L*) was significantly lower in LMX treatment than CON treatment while yellowness (b*) was significantly lowest in CON treatment ($P < 0.05$). Color, marbling and firmness score were improved in LMX treatment compared with LC treatments. In conclusion, dietary mannanase and xylanase supplementation improved growth performance, nutrient digestibility, glucose concentration in blood and meat quality.

Key Words: enzyme, nutrient digestibility, finishing pigs

211 Allzyme SSF supplementation of cassava-based diets: Effects on performance and nutrient digestibility of weanling pigs. U. Kanto¹, S. Juttapornpong¹, W. Jintanawich¹, P. Sookpopet¹, and K. Filer*², ¹SARDI, Kasetsart University, Kampaengsaen, Nakhon Pathom, Thailand, ²Alltech Asia-Pacific Biosciences Center, Bangkok, Thailand.

Rising energy prices dictate increased use of cassava meal in Asia; however, its low protein content results in higher soybean meal inclusion and consequent digestive complications in weanling pigs. This experiment tested whether a solid state fermentation product containing a range of enzyme activities could improve nutrient availability in standard or lower-cost/higher cassava diets. One hundred and sixty (160) weaned pigs aged 28 days were divided into 20 groups of 8 pigs each housed in metal slatted floor pens with ad libitum feed and water for a 28d trial. Treatments consisted of positive and negative control diets (C+, C-) with or without Allzyme SSF (Alltech Inc.). The C+ diet (NRC, 1998) contained cassava (42.7%), SBM, full-fat soybeans and 5% fish meal. The C- diet was formulated to contain 75 less kcal/kg and 0.1% less Ca and available P, which resulted in higher cassava inclusion, less full-fat soy and use of 1.5% rice bran. In addition to growth and efficiency, nutrient digestibilities were determined via 0.25% chromic oxide inclusion in all diets days 44-49. Digesta pH, microbial ecology and villus morphology were examined on 2 pigs/treatment slaughtered day 49. Dry and organic matter digestibilities at were calculated by chromic oxide analysis of digesta. Data were subjected to ANOVA and means separated using Duncan's multiple range test. Daily gain was numerically reduced, and FCR poorer ($P < 0.05$) in the C- diet (1.75 vs 1.84). SSF increased ADG in the C+ diet (362.9 v 407.2 g/d, $P < 0.05$) with numerical increases in the C- diet. OM and total tract digestibilities were reduced in the C- diet ($P < 0.05$), but increased with SSF addition to both C+ and C- diets ($P < 0.05$). Notably, both performance criteria and digestibilities of the SSF-supplemented C- diet did not differ significantly from the positive control. Digesta pH, microbial populations, VFA production and villus morphology were unaffected by treatment. It was concluded that it was possible to use SSF to improve performance and efficiency in standard diets or to allow similar performance from lower cost formulations.

Key Words: cassava, enzyme, digestibility

212 Effect of inclusion of two commercial carbohydrase enzymes in diets with a high level of distillers dried grains with solubles (DDGS) on the growth performance of nursery pigs. M. E. Mercedes*¹, C. L. Puls¹, M. Ellis¹, A. M. Gaines², B. A. Peterson², M. Kocher², and B. F. Wolter², ¹University of Illinois, Urbana, ²The Maschhoffs, Carlyle, IL.

The effects of inclusion of two proprietary carbohydrase enzymes (enzyme A: thermostable xylanase and enzyme B: galactomannase, beta-glucanase, xylanase, and alpha-galactosidase cocktail) in diets with DDGS (30% inclusion) were evaluated in a nursery study involving 252 barrows from week 2 (BW 10.4 ± 0.16 kg) to week 7 (BW 32.7 ± 2.4 kg) post-weaning. A RCBD was used with 4 dietary treatments: 1) Control, no enzyme; 2) Control + enzyme A at 0.14 kg/tonne; 3) Control + enzyme A at 0.27 kg/tonne; and 4) Control + enzyme B at 0.23 kg/tonne. There were 9 pigs per pen and 8 pens per treatment.

Pigs had ad libitum access to feed and water throughout the study. Diets were formulated to be isocaloric and to a common standard ileal digestible lysine:ME ratio. Pigs were weighed every week throughout the study period and all feed additions and feed remaining in the feeder were recorded at the time of pig weighing. Compared to the control treatment, enzyme supplementation did not improve ($P > 0.05$) growth performance. There was a difference ($P < 0.05$) between the enzyme treatments for growth performance; pigs fed enzyme A at the lowest inclusion level (0.14 kg/tonne) were heavier, at the end of the study (33.0, vs. 32.3 vs. 32.1 vs. 31.5 kg for Treatments 2, 1, 3, and 4, respectively; SEM 2.19), and grew faster during the study (0.676 vs. 0.658 vs. 0.649 vs. 0.635 kg/day, respectively; SEM 0.0331), but had similar ($P > 0.05$) feed intake and feed efficiency compared to the other 2 enzyme treatments. Results from this study suggest that including these enzymes, at the levels evaluated, in nursery diets containing 30% DDGS did not improve growth performance.

Key Words: enzymes, nursery pigs, DDGS

213 Evaluation of the interaction between lysine level, OptiPak efficiency, and ractopamine hydrochloride (Paylean) on growth performance of late finishing pigs. R. Howdyshell*¹, S. A. Hansen¹, R. E. Musser², and E. L. Hansen³, ¹Hubbard Feeds, Mankato, MN, ²SODA Feed Ingredients LLC, Mankato, MN, ³New Fashion Pork, Jackson, MN.

An experiment was conducted to determine the interactive effects between available lysine (aLys), OptiPak Efficiency Micro (OPE), and Paylean (P5) on growth and feed efficiency in late finishing pigs. A total of 939 barrows (TR4 * FAST; initial BW = 80 kg) were used in the evaluation that was conducted at a research site in southern MN in January 2009. Seven treatments were evaluated, with treatments consisting of 3 levels of aLys at 0.6, 0.8, 1.0%, with additional treatments being combinations of OPE (2 lb/ton) and/or P5 (5ppm). Dietary treatments were as follows: 0.60% aLys, 0.60% aLys + OPE, 0.80% aLys, 0.80% aLys + P5, 0.80% aLys + P5+ OPE, 1.0% aLys, 1.0% aLys + P5. Performance was measured in two phases, with the initial phase beginning with the use of diets without P5 from d 0-21 of the exp, and with P5 during the final phase (d 21-40). Pigs were weighed and feed consumption for the period was measured on d 0, 21, and 40 of the exp. Results from phase one indicated that neither aLys level nor OPE influenced ($P > 0.05$) ADG or G:F. This demonstrated that when aLys is not limited, OPE does not influence performance. During the second phase, multiple differences occurred ($P < 0.05$): aLys had a linear influence on ADG (958, 994, and 1035 g/d) and G:F (0.28, 0.29, and 0.31), use of P5 improved G:F at 0.80% aLys (0.32 vs 0.29), and both ADG and G:F at 1.0% aLys (1194 vs 1035 g/d, and 0.36 vs 0.31). Pigs fed P5 and 0.80% aLys benefited from OPE in both ADG and G:F (1185 vs 1049 g/d, and 0.35 vs 0.32; $P < 0.05$). As hypothesized, the use of OPE in combination with P5 in diets at 0.80% aLys, could perform at the same level for ADG and G:F as 1.0% aLys diets with P5 (1185 vs 1194 g/d, and 0.35 vs 0.36; $P > 0.10$). Use of OPE in P5 diets allows for a lower aLys formulation which results in an economic advantage.

Key Words: lysine, OptiPak efficiency, Paylean

214 The effects of deoxynivalenol on growth performance in nursery pigs. S. L. Johnston¹, J. F. Patience², D. Gillis², M. De La Llata^{*1}, S. A. Hansen¹, and A. D. Beaulieu², ¹Hubbard Feeds, Mankato, MN, ²Prairie Swine Centre, Inc., Saskatoon, SK, Canada.

A 22 d experiment was conducted to determine the effect of the mycotoxin deoxynivalenol (DON) on feed intake, gain, and feed efficiency of nursery pigs. Eighty nursery pigs (initial weight = 9.03 kg), were allotted to 2 treatments with 5 pens of gilts and 5 pens of barrows and 4 pigs per pen for each treatment. The 2 treatments were; 1) a diet with no detectable DON contamination; and 2) a diet with 1.57 ppm DON from naturally contaminated corn. Deoxynivalenol concentration in the corn and treatment diets was determined using ELISA methods. All pigs were fed a common diet for 13 d after weaning; at that time they were weighed and feeding of treatment diets started. Pigs were weighed on d 9, d 17, and d 22 after the initiation of treatment diets. Feed efficiency was higher in the pigs fed DON contaminated feed for d 0 – 9 ($P < 0.06$) but not for any other feeding period or overall ($P > 0.20$). For d 0 – 9 and d 9 – 17 there was no effect of DON on ADFI ($P > 0.20$). From d 17 – 22 feeding diets contaminated with DON decreased ADFI by 10.0% (1,178 vs 1,060 g/d; $P < 0.07$). For the overall feeding period, ADFI decreased by 5.6% (823 vs. 777 g/d; $P < 0.03$). For d 0 – 9 and d 9 – 17 there was no effect of DON on ADG ($P > 0.20$). However, from d 17 – 22, ADG decreased by 13.7% (771 vs. 665 g/d; $P < 0.04$) and for the overall feeding period it was decreased by 4.9% (577 vs. 549 g/d; $P < 0.10$). Feeding diets naturally contaminated with 1.57 ppm DON decreased ADFI and ADG in nursery pigs.

Key Words: deoxynivalenol, mycotoxin, pig

215 Effects of mycotoxin binders and a liquid immunity enhancer on the growth performance of wean-to-finish pigs. J. Y. Jacela*, S. S. Dritz, J. M. DeRouchey, M. D. Tokach, R. D. Goodband, and J. L. Nelssen, Kansas State University, Manhattan.

A total of 1,120 pigs (BW=7.2 kg) were used in a study to evaluate the effects of 2 mycotoxin binders and a liquid immunity enhancer product (ARNap) on growth performance of wean-to-finish pigs. Pigs were randomly assigned to 1 of 4 treatments balanced by initial average BW within gender (10 pens/trt). Treatments were: 1) control standard phase-fed diets based on corn and soybean meal with DDGS (20 to 35%) fed for 132 d, 2) treatment 1 with mycotoxin binders Biomannan fed from d 0 to 55 and T-BIND fed from d 0 to 132, 3) treatment 1 with Biomannan and T-BIND fed from d 0 to 132, and 4) treatment 3 with ARNAP administered through the water lines of pens continuously for 7 d every 3 wk. The binders and the liquid immunity enhancer product were obtained from Biotech Development Company, Inc. (Dexter, MO). Pig weights and feed disappearance were obtained every 2 wk. Average BW, ADG, ADFI, and G:F were determined. Ingredients were not tested for nor artificially contaminated with mycotoxins. Analysis of complete feed did not detect the presence of mycotoxins. Overall, there were no treatment-by-gender interactions ($P > 0.73$). As expected, gender differences were noted as barrows had greater

($P < 0.01$) ADG and ADFI but poorer ($P = 0.02$) G:F than gilts. The addition of mycotoxin binders and ARNAP did not affect ADG ($P = 0.73$), ADFI ($P = 0.77$), G:F ($P = 0.97$) from d 0 to 132. In conclusion, in the absence of mycotoxin contamination, the additives had no effect on wean-to-finish pig performance.

Table 1. Effect of mycotoxin binders and ARNAP on pig performance.

	Treatment				SEM
	1	2	3	4	
T-BIND	-	+	+	+	
Biomannan (d 0 to 55)	-	+	+	+	
Biomannan (d 55 to 132)	-	-	+	+	
ARNAP	-	-	-	+	
BW, kg					
d 0	7.2	7.3	7.3	7.2	0.12
d 132	105.7	106.1	106.4	106.7	0.65
d 0 to 132					
ADG, kg	0.743	0.744	0.748	0.751	0.0051
ADFI, kg	1.69	1.70	1.71	1.71	0.017
G:F	0.439	0.439	0.437	0.439	0.0035

Key Words: growth, mycotoxin binder, pig

216 Effects of increasing hominy feed in diets on finishing pig performance. M. L. Potter*, 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 1,035 finishing pigs were used in an 84 d growth trial to evaluate the effects of increasing corn hominy feed on finishing pig growth performance. Pens of pigs with a similar number of barrows and gilts were blocked by average initial BW and randomly allotted to 1 of 4 dietary treatments in a randomized complete block design with initial weights balanced across treatments. Treatments were increasing levels (0, 12.5, 25, and 37.5%) of hominy feed added to a corn-soybean meal-based diet. All treatment diets were fed in 4 phases formulated for BW ranges of 36 to 59, 59 to 82, 82 to 104, and 104 to 141 kg with SID lysine levels of 0.96, 0.82, 0.72, and 0.64%, respectively. Hominy feed inclusion was constant among phases and was assigned a ME value of 3,210 kcal/kg for diet formulation. Chemical analysis indicated hominy feed contained 90.4% DM, 9.5% CP, 4.4% fat, 3.6% ADF, 10.0% NDF, 2.8% CF, 2.35% Ash, 0.02% Ca, and 0.51% P on an as-fed basis. Increasing hominy feed linearly decreased ($P < 0.01$) ADG and ADFI from d 0 to 84. Regardless of treatment, there were no differences ($P > 0.54$) in G:F. The lower feed consumption and poorer growth rate resulted in pigs fed diets containing any level of hominy feed weighing less than pigs fed standard corn-soybean meal-based diets on d 84. These data indicate that adding hominy feed as an alternative ingredient in swine diets is a viable option; however, a decrease in performance should be considered when deciding if it is cost-effective to include hominy feed in finishing diets.

Table 1. Effect of hominy feed inclusion in diets on finishing pig performance

Item	0	Hominy, %			SEM ¹
		12.5	25	37.5	
Pens/treatment ²					
D 0	10	10	10	10	—
D 84	8	9	10	8	—
D 0 to 84					
ADG, kg	1.02	0.97	0.96	0.93	0.010
ADFI, kg	2.87	2.68	2.68	2.59	0.042
G:F	0.36	0.36	0.36	0.36	0.004
Weight, kg					
D 0	36.0	35.7	36.0	36.1	0.93
D 84	121.7	116.9	117.4	114.9	1.18

¹The highest SEM among treatments is reported due to lost observations.

²Pens were removed due to diet delivery error or loss of integrity.

Key Words: hominy, growth, pig

217 Effects of feeding ractopamine HCl (Paylean) for various durations on finishing pig performance and carcass characteristics. M. L. Potter*, S. S. Dritz, M. D. Tokach, J. M. DeRouchey, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan.*

A total of 627 pigs (109.5 kg) were used in a 21-d trial to evaluate the effects of feeding ractopamine HCl (RAC; Elanco Animal Health, Greenfield, IN) for different durations on performance of heavy weight pigs. On d 0, 24 mixed-gender pens of pigs were blocked by BW and randomly allotted to treatments (8 pens/treatment) with BW balanced across treatments. Treatments were a control diet without RAC (CTRL) or a diet with 5 ppm RAC fed for the last 14 (14D) or 21 d (21D) prior to marketing. On d 7, the 4 heaviest pigs per pen were marketed. From d 0 to 7, 21D pigs had greater ($P = 0.01$) ADG and lower ($P = 0.01$) ADFI than CTRL and 14D pigs. From d 7 to 21, 14D pigs had improved ($P \leq 0.04$) ADG and G:F compared with CTRL and 21D pigs. There was no difference in overall ADG among treatments, but ADFI was lower ($P < 0.01$) and G:F improved ($P < 0.01$) for pigs fed RAC compared with CTRL pigs. There were no differences ($P \geq 0.32$) in live BW marketed or HCW. After adjustment to a common HCW, 21D pigs had reduced (21.9 ± 0.40 mm vs. 20.2 mm; $P < 0.01$) backfat depth (BF), increased (60.0 ± 0.66 mm vs. 62.0 ± 0.65 mm; $P = 0.01$) loin depth (LD), and improved ($51.6 \pm 0.20\%$ vs. 52.6% ; $P < 0.01$) percentage lean compared with CTRL pigs. While 14D pigs had intermediate responses for LD and BF these pigs had a higher ($52.2 \pm 0.20\%$; $P = 0.04$) percentage lean than CTRL pigs. Thus, for heavyweight pigs, G:F and ADFI responses are achieved with either duration of RAC feeding, but the magnitude of the carcass response to feeding RAC appears duration dependent.

Table 1. Effect of ractopamine HCl on performance of finishing pigs

Item	CTRL	14D	21D	SEM	TRT, P <	CTRL & 14D vs. 21D, P <
D 0 to 7						
ADG, kg	1.04	1.09	1.26	0.061	0.04	0.01
ADFI, kg	3.59	3.58	3.40	0.055	0.04	0.01
G:F	0.29	0.30	0.37	0.015	<0.01	<0.01
D 7 to 21						
ADG, kg	0.94	1.02	0.89	0.029	<0.01	—
ADFI, kg	3.49	3.22	3.13	0.066	<0.01	—
G:F	0.27	0.32	0.28	0.008	<0.01	—
D 0 to 21						
ADG, kg	0.98	1.05	1.02	0.030	0.14	—
ADFI, kg	3.53	3.35	3.23	0.054	<0.01	—
G:F	0.28	0.31	0.32	0.008	<0.01	—

Key Words: growth, Paylean, pig

218 Evaluation of a fortified nutrient pack (FNP) and graded levels of Lys on growth performance and total tract apparent digestibility of nutrients in 100-kilogram pigs. V. D. Naranjo*¹, S. L. Johnston², T. D. Bidner¹, R. Musser³, and L. L. Southern¹, ¹LSU Agricultural Center, Baton Rouge, LA, ²Hubbard Feeds Inc., Mankato, MN, ³Soda Feed Ingredients, Mankato, MN.

The effect of FNP (0 or 0.10%) and graded levels of SID Lys (0.30, 0.40, 0.50% for barrows; 0.35, 0.45, 0.55% for gilts) on growth performance and apparent total tract digestibility (1% acid insoluble ash as marker) of DM, CP, and GE in 100-kg pigs was assessed. The FNP contained fumaric, malic, citric, phosphoric, and lactic acids, L-carnitine, chromium picolinate, inulin, d-pantothenic acid, and niacin. A total of 90 pigs (n = 48 barrows and n = 42 gilts; initial BW = 100 kg) were allotted within sex to 6 dietary treatments with 3 pens of 2 or 3 pigs per pen in a 2 x 3 factorial arrangement. Fecal samples were collected on d 12 and 13 (phase 1) and on d 26 and 27 (phase 2) and combined within day, pig, and pen at the end of each phase. In barrows, overall ADG (831, 928, 978 g/d; $P = 0.01$) and G:F (0.25, 0.28, 0.28; $P = 0.06$) were linearly increased as SID Lys increased. The FNP addition reduced overall ADG (876 vs. 948 g/d $P = 0.07$), but ADFI and G:F were not affected ($P > 0.10$). There was a quadratic effect ($P < 0.03$) in DM (87, 84, 85%) GE (85, 81, 81%), and CP (71, 66, 72%) digestibility during phase 2 and GE (68, 64, 71%; phase 1) digestibility as SID Lys increased. The FNP addition ($P < 0.08$) increased DM (84 vs. 82%; phase 1), and DM (86 vs. 84%), and CP (71 vs. 69%) digestibility during phase 2. In gilts, overall growth performance was not affected ($P > 0.10$) as SID Lys increased or with FNP addition. There was a linear effect ($P < 0.07$) in GE (64, 67, 72%; phase 1), CP (67, 72, 71%; phase 2), and a quadratic effect ($P < 0.06$) in CP (80, 82, 80%; phase 1), DM (84, 85, 83%; phase 2), and GE (81, 82, 79%; phase 2) as SID Lys increased. The FNP addition increased CP (81 vs. 79%; $P = 0.06$) digestibility during phase 1. Based on these results, the inclusion of FNP improved DM and CP digestibility in barrows and CP digestibility during phase 1 in gilts, but overall ADG was reduced in barrows and growth performance was not affected in gilts.

Key Words: finishing pigs, digestibility

219 Effects of diets containing various concentrations of fumonisin (FB₁) supplied by naturally contaminated corn on performance, blood, and liver chemistry of nursery pigs. S. Turner*, D. R. Ledoux, G. E. Rottinghaus, and M. C. Shannon, *University of Missouri-Columbia, Columbia.*

This study was conducted to determine the effect of diets containing various concentrations of fumonisin FB₁ in naturally contaminated corn on nursery pig's performance, blood and liver chemistry. A 21 d study was conducted using 30 two wk old post-weaned individually penned barrows with an initial weight of 6 kg (± 2 kg) in a RCBD using 6 replications were allotted to 1 of 5 dietary treatments containing different concentrations of FB₁. Treatments were a Phase 2 nursery pig diet supplemented with 0 ppm FB₁ (control), 20 ppm FB₁, 30 ppm FB₁, 40 ppm FB₁, and 50 ppm FB₁. Fumonisin B₁ was supplied by naturally contaminated corn containing 135 ppm FB₁. Pigs tended to have a quadratic reduction in ADG when fed increasing concentrations of corn naturally contaminated with FB₁ ($P = 0.1$). Feed intake and gain to feed were not affected by dietary treatments ($P > 0.05$). On d 21, pigs were sacrificed and blood was collected for evaluation of serum chemistry and pathology. Pigs fed 50 ppm FB₁ had higher gamma-glutamyl transferase concentrations (92.5 IU/L) than pigs fed 0, 20, 30, or 40 ppm FB₁ (52.8 IU/L; $P < 0.01$). Pigs fed 40 or 50 ppm FB₁ had higher aspartate aminotransferase concentrations (103.5 IU/L) than pigs fed 0, 20, or 30 ppm FB₁ (57.3 IU/L; $P < 0.01$). Other serum biomarkers such as albumin, total protein, globulin, total bilirubin, and direct bilirubin were not altered by dietary treatments ($P > 0.05$). Liver sphinganine (SA) to sphingosine (SO) ratio was higher in pigs fed 40 and 50 ppm FB₁ at 1.9 and 2.3, respectively ($P < 0.05$) compared to pigs fed 0 (0.005), 20 (0.53), or 30 (1.14) ppm FB₁. Relative liver and lung weights were not affected by dietary FB₁ concentrations ($P > 0.05$). In conclusion, results indicate that pigs fed diets containing up to 30 ppm FB₁, supplied by naturally contaminated corn, and fed for 21 d was not deleterious to nursery pig performance, blood and liver chemistry.

Key Words: pigs, sphingolipids, fumonisin

220 Effect of two adsorbents on performance, blood, and liver chemistry of nursery pigs fed diets containing fumonisin (FB₁) supplied by naturally contaminated corn. S. Turner*, D.R. Ledoux¹, G.E. Rottinghaus¹, J. Broomhead², and M.C. Shannon¹, ¹*University of Missouri-Columbia, Columbia,* ²*Amlan International, Vernon Hills, IL.*

Two 21 d experiments were conducted to evaluate the efficacy of clay-based adsorbents, with high in vitro binding efficacy for FB₁, to reduce the toxic effects of FB₁ present in naturally contaminated corn used to produce diets for nursery pigs. Exp. 1 and 2 utilized 30 and 32 individually penned barrows, respectively (6.4 \pm 0.9 kg and 6.7 kg \pm 0.8 kg, respectively) and allotted to 1 of 6 or 4 dietary treatments using 5 or 8 replications in a 2 \times 3 or 2 \times 2 factorial arrangement with either 3 (0, 20, and 50 ppm) or 2 (0 and 50 ppm) levels of FB₁ and supplemented with or without 0.5% carbonized clay (CC) or clay-activated carbon (AC) mixture. ADG and FE were not affected ($P > 0.05$) by dietary treatments. In Exp. 1, pigs fed 20 or 50 ppm FB₁ without CC showed a 14 % reduction in ADFI ($P < 0.05$) compared to pigs fed control, 20 or 50 ppm FB₁ + CC. Pigs fed 20 ppm FB₁ + CC had an increase in serum gamma glutamyl transferase (GGT) compared to pigs fed the control with or without CC ($P < 0.05$). Pigs fed control diet had a lower liver sphinganine (SA) to sphingosine (SO) ratio ($P < 0.05$) compared to pigs fed 50 ppm FB₁ with CC. Pigs fed 20 ppm FB₁ + CC had higher

liver SA to SO ratio ($P < 0.05$) compared to pigs fed 50 ppm FB₁ + CC. In Exp. 2 pigs fed 50 ppm FB₁ and 50 ppm FB₁ + AC had a 40 and 23% reduction in overall ADG and feed efficiency, respectively ($P < 0.05$) compared to pigs fed the control diet. Pigs fed 50 ppm FB₁ with or without AC had an increase in serum AST and GGT ($P < 0.05$). Pigs fed 50 ppm FB₁ with or without AC had an increase in liver SA to SO ratio ($P < 0.05$) compared to pigs fed the control diet. In conclusion, modified clay adsorbents that have high in vitro binding capacity for FB₁ may not improve nursery pig performance or blood and liver chemistry of pigs fed corn naturally contaminated with 50 ppm FB₁.

Key Words: pigs, sphingolipids, fumonisin

221 Ractopamine (Paylean) response in heavy weight finishing pigs. L. W. Kutzler*¹, C. M. Peterson¹, M. Ellis¹, S. N. Carr², M. J. Ritter², T. A. Armstrong², F. K. McKeith¹, and J. Killefer¹, ¹*University of Illinois at Urbana-Champaign, Urbana,* ²*ELANCO Animal Health, Greenfield, IN.*

The objective of this study was to investigate the effects of feeding diets with 10 ppm ractopamine HCL (RAC) to heavy weight pigs (final live weight of 147 kg). Few studies, address the effects of RAC on performance and carcass traits at the finishing weights presented in this study. This study was carried out as a randomized complete block design with a 2 x 2 factorial arrangement of treatments: 1) gender (barrow or gilt); and 2) RAC inclusion (0 ppm or 10 ppm), with a total of 128 pigs. Pigs were randomly assigned to pens of 4 and starting weight was approximately 115 kg. After 28 days on test pigs were harvested, and a subset of pigs, totaling 64 pigs (2 pigs/pen), were selected for carcass characteristics and meat quality analysis. There were no gender \times RAC interactions ($P > 0.10$). Final farm BW was increased by 3.3 kg ($P = 0.003$), overall ADG was increased by 11.0% ($P = 0.009$), and overall G:F was increased 12.9% ($P < 0.0001$) with RAC. HCW was increased by 3.9 kg with RAC ($P < 0.0001$), and dressing percentage was increased by 0.98% units ($P = 0.001$). In the subset selected for carcass characteristics (n = 64), there was a trend ($P = 0.08$) of increasing lean cut yield by 0.61 % units. Ultimate pH was increased by 0.08 units ($P < 0.0001$), and drip loss was decreased 1.28 % units ($P = 0.011$) with RAC. Feeding 10 ppm RAC to pigs with ending live weights of approximately 147 kg proved efficacious in improving BW, ADG, G:F, HCW, and dressing percentage without adversely affecting meat quality traits.

Key Words: ractopamine, cutting yields, finishing performance

222 Starch and energy digestibility of field peas (*Pisum sativum*). C. A. Montoya, A. D. Beaulieu*, and P. Leterme, *Prairie Swine Centre, Inc., Saskatoon, SK, Canada.*

Starch is the main source of digestible energy (DE) in peas for pigs. However, little information is available on the rate of starch hydrolysis (RH) in the small intestine. The objective of this experiment was to develop and validate an in vitro method for intestinal starch hydrolysis. A sequential procedure using pepsin for 120 min followed by a mixture of pancreatin, isomaltase and maltase for 240 min was standardized and used on 8 pea varieties (Bronco, Centinal, Circus, Cooper, Mozart, Noble, Sage and Thunder) specifically selected to have a wide range of starch and protein content. Aliquots taken at 360 min were analyzed for soluble glucose to calculate RH. Eight barrows (132 kg) fitted with T-cannulas at the terminal ileum were fed a semi-synthetic diet containing 60% peas and supplemented with 0.3 % Cr₂O₃ as an

indigestible marker. Ileal samples were collected for 3 d following 4 d of diet acclimation until 6 replicates were obtained for each pea sample. A protein-free synthetic diet (69% pea starch, 13% cellulose and 10% sugar) was then fed to determine isolated pea starch digestibility. Starch RH determined using in vitro or in vivo techniques was similar ($r = 0.89$; $P < 0.01$) but differed between varieties ($P < 0.001$). RH was highest for Noble, Cooper and Thunder pea varieties (75, 76, and 70%, respectively) and lowest for Centinal, Circus and Sage varieties (54, 56 and 57%, respectively). Prediction equations for the DE content of 5 pea samples were developed using the in vitro technique and validated in vivo using 30 growing pigs (28 ± 2 kg) fed a basal diet or 5 pea-based diets (70% basal diet and 30% peas) supplemented with AIA, as an indigestible marker. Faecal samples were collected for 3 d following a 10 d diet adaptation and the DE content determined. Significant correlations were observed between DE and RH ($r = 0.57$) and DE and pea ADF content ($r = -0.67$). The best prediction equation used ash and ADF content ($DE = 5.04 - 0.02\text{Ash} - 0.016\text{ADF}$; $r^2 = 0.55$, $P = 0.06$). In conclusion, in vitro starch hydrolysis can be used to estimate DE content of field peas.

Key Words: field peas, starch digestion, pigs

223 Standardized ileal amino acid digestibility of field peas (*Pisum sativum*) in adult pigs. C. A. Montoya, A. D. Beaulieu*, and P. Leterme, *Prairie Swine Centre, Inc., Saskatoon, SK, Canada.*

Nutrient digestibility coefficients are typically higher in adult pigs or sows relative to growing pigs. Amino acid digestibility however, is usually determined in growing pigs. This experiment determined the standardised ileal digestible (SID) AA content of eight commercial field pea varieties using 132 kg barrows. Eight barrows fitted with T-cannulas at the terminal ileum were fed a semi-synthetic diet containing 60% peas as the only source of protein and supplemented with 0.3% Cr_2O_3 as an indigestible marker. Ileal digesta samples were collected for 3 d following 4 d of diet acclimation, until 6 replicates were obtained for each pea variety. The pigs were then fed a protein-free synthetic diet to measure endogenous N losses. Diet and digesta samples were analysed for N, AA and Cr_2O_3 content. The SID AA (%) was 89.4 ± 1.3 , 80.7 ± 1.7 , 73.2 ± 3.5 , 77.7 ± 2.1 , 83.7 ± 1.5 , 69.4 ± 4.6 , 77.0 ± 2.9 , 70.5 ± 2.6 , and 72 ± 3.5 ; and the SID AA content (g/kg dry peas) was 78.6 ± 7.6 , 20.5 ± 0.5 , 27.7 ± 3.1 , 57.2 ± 2.2 , 63.5 ± 4.4 , 7.2 ± 1.2 , 37.3 ± 1.2 , 29.1 ± 0.9 , and 30.5 ± 3.4 for Arg, His, Ile, Leu, Lys, Met, Phe, Thr and Val, respectively. The SID content of Ile, Met and Val differed between varieties ($P < 0.05$). Ileal N digestibility averaged 82.2 ± 2.0 and differed between varieties ($P < 0.05$). Average SID values were higher than those reported by NRC (1998) in growing pigs. In conclusion, the SID AA values for field peas must be determined in both adult and growing pigs.

Key Words: field peas, SID AA, adult pigs

224 Effects of added copper sulfate and zinc oxide on weanling pig growth and plasma mineral levels. N. W. Shelton*¹, M. D. Tokach¹, J. L. Nelssen¹, R. D. Goodband¹, S. S. Dritz¹, J. M. DeRouchey¹, G. M. Hill², R. G. Amachawadi¹, and T. G. Nagaraja¹, ¹*Kansas State University, Manhattan*, ²*Michigan State University, East Lansing.*

A total of 216 weanling pigs (PIC TR4, initially 6.2 kg and 21 d) were used in a 42-d trial to compare the effects of supplemental zinc and copper on growth performance and plasma mineral levels. Six dietary treatments were allotted in a RCBD and included a 2×2 factorial with

main effects of added copper from CuSO_4 (0 or 125 ppm) and added zinc from ZnO (0 or 3,000 ppm from d 0 to 14 and 0 or 2,000 ppm from d 14 to 42). The final 2 treatments were ZnO alone or in combination with CuSO_4 from d 0 to 14 with CuSO_4 fed d 14 to 42. There were 6 pens per treatment with 6 pigs per pen. All diets contained an additional 165 ppm zinc and 16.5 ppm copper provided by the premix. Plasma was collected from 2 pigs per pen on d 14 and 42. From d 0 to 14, ADG, ADFI, and G:F were improved ($P < 0.04$) with the addition of dietary zinc. From d 14 to 42, added copper increased ($P < 0.003$) ADG and ADFI. From d 0 to 42, continuous supplemental zinc increased ($P < 0.03$) ADG and tended to increase ($P < 0.09$) ADFI. Dietary copper also increased ($P < 0.004$) ADG and ADFI from d 0 to 42. The most advantageous values for ADG and G:F were in pigs fed 3000 ppm of zinc from d 0 to 14 and 125 ppm copper from d 14 to 42. Plasma zinc levels were also increased ($P < 0.001$) with zinc supplementation on d 14. These results indicate that each mineral regimen improved ($P < 0.05$) weanling pig growth performance compared to the control and the greatest numerical performance was observed when adding ZnO from d 0 to 14 and CuSO_4 from d 14 to 42.

Table 1.

d 0 to 14 diet	Control	Cu	Zn	Cu & Zn	Zn	Cu & Zn	
d 14 to 42 diet	Control	Cu	Zn	Cu & Zn	Cu	Cu	SEM
d 0 to 14							
ADG, g	146 ^a	182 ^b	212 ^{bc}	222 ^c	217 ^{bc}	222 ^c	13.3
ADFI, g	220 ^a	261 ^b	256 ^{ab}	274 ^b	267 ^b	274 ^b	14.7
d 14 to 42							
ADG, g	586 ^a	634 ^c	605 ^{ab}	632 ^{bc}	643 ^c	618 ^{bc}	17.9
ADFI, g	910 ^a	986 ^b	956 ^{ab}	1005 ^b	998 ^b	975 ^b	34.3
d 0 to 42							
ADG, g	440 ^a	483 ^{bc}	473 ^b	495 ^{bc}	501 ^c	486 ^{bc}	14.9
ADFI, g	680 ^a	745 ^b	720 ^{ab}	761 ^b	754 ^b	741 ^b	27.0

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

Key Words: copper, growth promotion, zinc

225 Effect of feeding organic and inorganic zinc on growth performance, zinc absorption and immune response of weanling pigs. T. S. Jeong*, S. W. Lee, Y. D. Jang, L. G. Piao, and Y. Y. Kim, *Seoul National University, Seoul, Korea.*

This experiment was conducted to evaluate the effect of dietary zinc sources and level on growth performance, plasma Zn concentration, and immune response (IgA and IgG) in weanling pigs. A total of 144 crossbred pigs, weaned at 24 ± 3 days of age with average initial body weight of 8.04 ± 0.03 , were allotted to 6 treatments in 6 replicates with 4 pigs per pen in a randomized completely block (RCB) design. Pigs were fed in three dietary phase during 5 weeks (Phase 1, d 0 to 7; Phase 2, d 8 to 21; Phase 3, d 22 to 35). Treatments were: 1) In1 (140 ppm of zinc from ZnSO_4), 2) In2 (280 ppm of zinc from ZnSO_4), 3) In3 (560 ppm of zinc from ZnSO_4), 4) Or1 (70 ppm of zinc from Zn-Met), 5) Or2 (140 ppm of zinc from Zn-Met), 6) Or3 (280 ppm of zinc from Zn-Met). During the 5 weeks, there were no significant differences in the body weight, average daily gain (ADG) and feed efficiency among the treatments. For phase 2 treatment In3 supplemented Zn as ZnSO_4 showed the lowest ($P < 0.10$) ADG (In1:456, In2:444, In3:392, Or1:444, Or2:464 and Or3:470g, respectively). For the comparison of different sources at different levels (In1 vs. Or1, In2 vs. Or2, In3 vs.

Or3), Or3 showed higher ADFI ($P < 0.05$) at Phase 1, higher BW ($P < 0.01$), ADG ($P < 0.01$) and ADFI ($P < 0.05$) at Phase 2 and higher BW ($P < 0.05$) at Phase 3 than In3. For Zn, Cu and Fe concentrations in blood, no significant differences were observed among all treatments. Supplementation of Zn both from ZnSO₄ and Zn-Met did not affect the level of IgA and IgG among treatments during the overall period. Diarrhea incidence (average head/day) was highest in treatment In3 at Phase 2 ($P < 0.05$) and Phase 3 ($P < 0.10$) and lowest in treatments (In1, Or2 and Or3) at Phase 2 ($P < 0.05$) and Phase3 ($P < 0.10$). These results suggested that there were no effects on immune response and zinc concentration in pig fed Zn from ZnSO₄ and Zn-Met under pharmacological concentration but organic zinc showed positive effects for diarrhea incidence from Phase 2 to Phase 3.

Key Words: organic zinc, inorganic zinc, weaning pigs

226 Evaluation of feed budgeting, complete diet blending, and corn-supplement blending on finishing pig performance. R. C. Sulabo^{*1}, G. Papadopoulos¹, J. R. Bergstrom¹, J. M. DeRouche¹, D. Ryder², M. D. Tokach¹, S. S. Dritz¹, R. D. Goodband¹, and J. L. Nelssen¹, ¹Kansas State University, Manhattan, ²Feedlogic Corp., Willmar, MN.

A total of 283 pigs (PIC TR4 × 1050; initially 35 kg BW) were used to compare phase feeding to blending finishing diets using the FEEDPro system (Feedlogic Corp., Willmar, MN). There were three experimental treatments: (1) a standard 4-phase complete feed program (Phase feeding), (2) blending a high and low lysine complete diet over entire experiment (Curve), and (3) blending ground corn and a separate complete supplement within each phase (Supplement). FEEDPro is an integrated feed dispensing system that can deliver and blend two separate diets while dispensing. The four phases were from 35 to 55, 55 to 80, 80 to 100, and 100 to 126 kg. Each treatment had 12 replicate pens and 8 pigs per pen. Overall (35 to 126 kg), ADG and ADFI were similar ($P > 0.24$) across treatments. However, pigs on the Curve and Phase feeding treatment had greater ($P < 0.01$) and tended to have greater ($P < 0.09$) G/F than the Supplement treatment, respectively. There were no differences ($P > 0.70$) in HCW, percentage yield, and loin depth across treatments. The Supplement treatment had greater ($P < 0.02$) percentage lean and lower ($P < 0.04$) fat depth than pigs on the Curve and Phase feeding treatment. There were no differences ($P > 0.28$) in income over feed costs (IOFC) across treatments. In conclusion, the FEEDPro system blended separate complete diets or a ground corn-supplement combination without affecting growth performance.

Table 1. Effects of feed blending using FEEDPro on overall finishing pig performance

	Phase Feeding	Curve	Supplement	SE
ADG, kg	0.95	0.94	0.94	0.01
ADFI, kg	2.79	2.71	2.79	0.03
G/F	0.342 ^{ax}	0.345 ^a	0.336 ^{by}	0.002
HCW, kg	94.0	93.7	92.6	1.2
Yield, % ¹	73.9	74.4	73.6	0.4
Lean, % ¹	52.1 ^a	52.2 ^a	52.9 ^b	0.2
Fat depth, ¹ mm	21.2 ^a	20.6 ^a	19.2 ^b	0.5
Loin depth, ¹ mm	60.8	60.7	60.5	0.9
IOFC, \$/pig	55.29	56.86	54.91	1.03

^{a,b} $P < 0.05$; ^{x,y} $P < 0.09$.

¹Adjusted with HCW as covariate.

Key Words: Feed blending, growth, carcass characteristics

227 Effects of lactose and milk-yeast on growth performance, fecal microbiota, and immune responses of nursery pigs. H. Tran^{*}, J. W. Bundy, E. Hinkle, R. Moreno, J. Walter, T. E. Burkey, and P. S. Miller, *University of Nebraska, Lincoln.*

An experiment was conducted to evaluate the effects of dietary lactose alone or in combination with a milk-yeast product (50% near-dated milk; 50% dried yeast) on growth performance, fecal microbiota, and immune parameters in nursery pigs. A total of 108 pigs (age, 20 ± 1 d; initial BW, 6.07 ± 0.03 kg) was randomly allotted to 18 pens (6 pigs/pen; 6 pens/treatment). Dietary treatments were: 1) control (CTL, no lactose and milk-yeast), 2) CTL + lactose, or 3) CTL + lactose + 5% milk-yeast. Except for the CTL, diets in Phase 1 (wk 1 and 2), 2 (wk 3 and 4) and 3 (wk 5) contained 20, 15, and 5% total lactose, respectively. Blood samples were collected from all pigs at d 0, 14, 28, and 35 to determine circulating immunoglobulin (Ig) G, A, and tumor necrosis factor (TNF)-α concentrations. At d 0, 7, 14, fecal samples were collected (n = 18; 6 pigs/treatment) to evaluate fecal microbiota using PCR-DGGE. Compared to the CTL, pigs fed lactose and lactose with milk-yeast tended ($P = 0.07$) to have greater BW and ADFI and had greater ($P = 0.05$) ADG during Phase 1. There were no differences for BW, ADG, or ADFI during Phase 2, 3, or the overall experimental period. A main effect of treatment was observed for circulating IgA where CTL pigs had greater ($P < 0.01$) IgA compared to pigs fed lactose with or without milk-yeast; however, no effects of treatment were observed for circulating IgG or TNF-α. No differences in microbial diversity indices were observed on d 7 or 14 among treatments. However, a shift in microbial composition was observed on d 7 with lactose-fed pigs having greater ($P = 0.05$) putative *L. johnsonii* staining intensity compared to CTL pigs and pigs fed lactose plus milk-yeast. On d 14, *L. reuteri* tended ($P = 0.15$) to be enhanced, and *L. delbrueckii* was eliminated ($P = 0.04$) by feeding lactose with or without milk-yeast. This research indicates that growth performance, immune parameters, and fecal microbiota may be affected by dietary inclusion of lactose alone, or in combination with milk-yeast.

Key Words: lactose, pig, yeast

228 Effects of a yeast-derived protein source (NuPro) with and without whey powder on piglet performance post-weaning. D. Henman¹, A. Murphy¹, and K. Jacques^{*2}, ¹Rivalea Australia, Corowa, NSW, Australia, ²Alltech Inc., Nicholasville, KY.

The hypothesis of this experiment was that yeast protein (NuPro, Alltech Inc.) included in diets for 39 days post weaning will improve performance of weaner pigs against a standard weaner dietary program containing whey powder (60% lactose) in the first 19 days only. Eight hundred entire male piglets (Large White x Landrace), average weight 7.7 kg, were allotted by weight to four dietary treatment groups at weaning (28 d). For each of 4 replicate weeks 200 pigs allocated to (50 pigs/treatment/week). They were in groups of 10 pigs per pen (0.5 m²/pig). The experiment was divided into two periods: 0-19 and 19-39 days after weaning, respectively. The diet program of treatment A involved diets of 14.9 MJ DE/kg and 13.4 g/kg available lysine containing 10% whey powder offered between weaning and day 19 (period 1) and diets of 14.5 MJ DE/kg and 12 g/kg of available lysine offered from day 19 to 39 post weaning (period 2). Treatment B was a similar program except whey powder was not formulated into the period 1 diet. Treatment C diets had included 10% whey powder in period 1 and 4% NuPro formulated into both periods. Treatment D diets contained no whey powder in period 1 and 4% NuPro formulated into both periods. All pigs were

offered treatment diets ad libitum in a pelleted form. Parameters evaluated included pen start weight and individual weights at 0 and 39 days, pen feed intake, feed conversion ratio (FCR), and mortality. Data were subjected to ANOVA with pen as the experimental unit. Dietary whey powder significantly improved growth and FCR of weaner pigs in the absence of NuPro. NuPro inclusion without whey powder improved performance significantly during period 1. Over the entire experiment, contrast analysis showed piglets fed diets containing NuPro were heavier than pigs that did not (23.3 ± 0.6 vs 26.0 ± 0.6 kg, $P < 0.001$) with better FCR (1.43 ± 0.03 vs 1.32 ± 0.03 , $P < 0.001$) and feed intake (0.57 ± 0.02 vs 0.62 ± 0.02 kg, $P < 0.001$). In conclusion, post-weaning NuPro supplementation improved piglet performance and feed intake in excess of that expected based on the nutritional value of NuPro alone.

Key Words: yeast, starter diets, protein sources

229 Effect of replacing fish meal with synthetic amino acids or soy protein concentrate in nursery diets containing distillers dried grains with solubles. C. L. Bradley*¹, C. V. Maxwell¹, Z. B. Johnson¹, J. L. Usry², and J. W. Frank¹, ¹University of Arkansas, Fayetteville, ²Ajinomoto Heartland LLC, Chicago, IL.

The objective of this study was to determine if fish meal (FM) could be replaced with synthetic amino acids (SAA), soy protein concentrate (SPC), or SAA plus omega 3 fatty acids (SAA+FO) such that the omega 3:6 ratio equaled the FM treatment in Phase 1 and 2 nursery diets containing good quality distillers dried grains with solubles (DDGS; 20% of diet). A positive control diet (PC) diet containing FM but no DDGS was also studied. Weaned pigs ($n = 210$; GPK35 \times EBU; 21 d of age; 7.11 ± 0.01 kg BW) were used in the 33 d growth study (6 pigs per pen and 7 pens per treatment). Pigs were fed one of the five dietary treatments during Phase 1 (d 1-7; 1.44% TID Lys) and Phase 2 (d 8-17; 1.39% TID Lys). In Phase 3 (18-33 d; 1.26% TID Lys), pigs were fed a corn-soy diet (PC) or corn-soy-DDGS diet (FM, SAA, SPC, and SAA+FO) supplemented with 0.40% L-Lys. All diets contained DL-Met, L-Thr, L-Trp, or L-Val in order to maintain ideal ratios of TID Met + Cys, Thr, Trp, and Val at minimums of 0.58, 0.60, 0.165, and 0.65 to Lys, respectively. Pigs consuming diets containing DDGS had greater ADG (115 vs. 84 g/d; $P = 0.02$) and BW (7.91 vs. 7.70 kg; $P = 0.03$) compared to PC for Phase 1. The final BW on d 33 of PC vs. pigs consuming DDGS were 22.8 vs. 23.2 kg ($P = 0.11$). During Phase 1, pigs consuming FM had greater ADG than SPC (127 vs. 94 g/d; $P = 0.05$) with SAA and SAA+FO (115 and 123 g/d) intermediate. There were no differences in ADFI or G:F during Phase 1. Overall ADFI of PC, SPC, FM, SAA, and SAA+FO were 669, 671, 727, 719, and 734 g/d, respectively ($P = 0.11$) and final BW were 22.8, 22.9, 23.4, 23.4, and 23.1 kg, respectively ($P = 0.46$). The results indicate that nursery pigs not only tolerate high levels of DDGS, but can have improved ADG and BW compared to pigs fed diets without DDGS. In addition, replacing FM with SAA or SAA+FO had no effect on growth performance.

Key Words: pigs, amino acids, fish meal

230 Dietary supplementation of bacitracin methylene disalicylate (BMD) on sow and piglet performance, immunoglobulin status, and milk composition. S. K. Baidoo*¹, R. B. A. Dahlen¹, L. Anil¹, D. A. Nelson², and J. E. Wheaton¹, ¹University of Minnesota, St. Paul, ²Alpharma Animal Health, Bridgewater, NJ.

An experiment was conducted to determine the effect of BMD supplementation to sow diets from d 99 of gestation and throughout lactation on immunoglobulin status of sows and piglets, sow milk nutrient composition, and performance of sows and piglets. Crossbred sows (Topigs, Landrace \times Yorkshire; $n=16$; parities= 2.4 ± 0.28) were randomly assigned to one of two dietary treatments. Diet 1 was corn-SBM control diet and Diet 2 was diet 1 supplemented with 275 ppm BMD. Sows were fed their respective diets from d 99 of gestation through weaning. Piglet weight and piglet blood samples (1 pig/litter/period) and sow weight, backfat, blood, and milk samples were taken on d 0, 9, and 18 of lactation. There were no differences in sow ADFI, body weight, or backfat changes during lactation. There were no differences between treatments in pre-weaning mortality, number of piglets weaned/litter and litter weaning weight. No differences were observed between treatments for sow milk CP, CF, or ash content (CP = 6.22 and 6.31%, CF = 8.19 and 8.06%, Ash = 0.72 and 0.75% Control and BMD-fed sows, respectively). Sow milk immunoglobulin status was not affected by treatments. The average IgG milk content was 0.10 and 0.12 mg/mL and IgA content was 2.15 and 2.38 mg/mL for Control and BMD-fed sows respectively. The average IgG sow serum content was 0.59 and 0.48 mg/mL and IgA content was 0.34 and 0.26 mg/mL for Control and BMD-fed sows respectively. The average IgA content of piglet serum was not affected by treatment (0.90 and 0.94 mg/mL for pigs from Control and BMD-fed sows respectively). However, the overall average IgG status in the serum of piglets nursing sows consuming BMD was significantly ($P = 0.04$) enhanced and was more than twice that of pigs nursing Control sows (0.27 and 0.58 mg/mL for pigs from Control and BMD-fed sows, respectively). In conclusion, dietary supplementation of BMD in late gestation and lactation did not influence sow milk nutrient composition but enhanced the immunoglobulin status of nursing pigs.

Key Words: bacitracin methylene disalicylate, immunoglobulins, swine

231 Impact of pollock fish oil supplementation to breeding females on reproductive performance and on growth, carcass, and meat quality characteristics of the progeny. O. F. Mendoza*¹, W. Xiao¹, A. Rojo¹, F. K. McKeith¹, M. Ellis¹, S. Weibel², J. Spencer², A. M. Gaines³, and P. J. Bechtel⁴, ¹University of Illinois, Urbana, ²JBS United, Sheridan, IN, ³The Maschhoffs, Carlyle, IL, ⁴USDA/ARS/SARU, Fairbanks, AK.

The impact of dietary supplementation of gilts and sows of Pollock oil on reproductive performance and on growth, carcass, and meat quality characteristics of the progeny was evaluated. The study was carried in 2 parts; Part I used parity 1 and 2 females ($n=105$) in a RCBD with 2 treatments: 1) Control (standard diets); 2) Pollock oil (PO; control diets + Pollock oil at 0.80%). Experimental diets were fed ~30 d prior to mating and during the subsequent gestation and lactation periods. Part II used the progeny ($n=806$) from these females and was carried from weaning (6.1 ± 0.1 kg BW) to a market weight of 124.5 ± 1.9 kg BW. Pigs were housed in mixed gender pens (10 or 12 pigs) and were fed standard corn-soybean meal diets during the study period after which they were harvested and carcass grading data collected. A sub-sample of pigs ($n=48$) was used for detailed carcass and meat quality evalua-

tion. In Part I, PO increased ($P < 0.05$) total piglets born (12.9 vs. 14.1; SEM 0.41), born alive (12.5 vs. 13.3; SEM 0.38) and weaned (10.1 vs. 11.3; SEM 0.21) per litter. There was no dam feeding treatment effect ($P > 0.05$) on other piglet, litter, or sow performance measures. In Part 2, there was no effect ($P > 0.05$) of PO on progeny ADG, ADFI or G:F; however, there was a trend ($P = 0.07$) for lower morbidity and mortality (8.7 vs. 4.4%) for the progeny of dams fed the PO compared to the control. Carcass yield was higher ($P < 0.05$) for pigs from dams on the PO treatment (76.7 vs. 76.1%; SEM 0.26) but there was no effect ($P > 0.05$) on any other carcass or meat quality characteristics. These results suggest that supplementing the diets of females prior to breeding through gestation and lactation increased litter size and tended to reduce morbidity and mortality without affecting the growth, carcass, or meat quality of the progeny.

Key Words: fish oil, reproductive performance, growth

232 Effect of fat supplementation in gestation on sow reproductive and lactation performance. S. K Jang*, P. S Heo, L. G Piao, H. F Long, and Y. Y Kim, *Seoul National University, Seoul, Korea.*

The aim of this experiment was to determine the influence of different levels of fat during pregnancy on reproductive performance of their progeny. A total of 41 F1 sows (Yorkshire x Landrace) were allotted to 4 treatments by completely randomized design. During gestation, sows were fed different treatments containing 1, 2, 3 or 4% of soybean oil. During lactation period (24 d), all sows were fed same diets containing 1% soybean oil. There were no significant differences in body weight and backfat thickness of sows at 110 d of gestation and 21 d after farrowing by different levels of fat. Although the change in body weight of gestating sows were similar among treatment groups, sows fed 3% soybean oil showed the lowest backfat thickness change during gestation period ($P < 0.05$) (3.94, 3.82, 1.78 and 5.58 mm back-fat thickness change after 110 d, 1, 2, 3 and 4%, respectively). The litter size, total born live, birth weight and weight gain of nursing piglets was not influenced by the inclusion level of soybean oil during gestation. The 3 and 4% soybean oil treatments tended to have lower mortality of nursing pigs in first lactation week than the 1 and 2% soybean oil treatments (7.12%, 7.64% vs. 5.50%, 5.83%, 1, 2 vs. 3, 4%, respectively). No effects were observed on weaning to estrus interval by the difference inclusion level of soybean oil (5.11, 4.81, 4.48 and 4.60 d, 1, 2, 3 and 4%, respectively). These results indicate that higher levels of fat in the sow diet did not show any beneficial effects on reproductive performance and weaning to estrus interval of sows except a low prewean mortality in early lactation.

Key Words: fat, multiparous sow, reproductive performance

233 Effect of live yeast supplementation on reproductive performance, immune function and performance of their progeny. Y. D. Jang*, G. Y. Lee, D. H. Kim, S. K. Jang, and Y. Y. Kim, *Seoul National University, Seoul, Korea.*

This experiment was conducted to investigate the effect of live yeast supplementation on reproductive performance and immune function. A total of 47 F1 sows (Yorkshire x Landrace) were allotted to 5 treatments by completely randomized design. The treatments were 1) CON (basal diet), 2) A (Gestation period - basal diet, Lactation period - 10^6 cfu/kg of yeast supplementation), 3) B (Gestation period - basal diet, Lactation

period - 10^7 cfu/kg of yeast supplementation), 4) C (Gestation period - 10^6 cfu/kg of yeast supplementation, Lactation period - 10^6 cfu/kg of yeast supplementation), 5) D (Gestation period - 10^7 cfu/kg of yeast supplementation, Lactation period - 10^7 cfu/kg of yeast supplementation). The lactation period was provided during 21 days. There were no significant differences on body weight and backfat thickness of sows at 110 days of gestation and 21 d after farrowing. The supplementation of live yeast in the sows' diet had no effects on litter size, birth weight and weight gain of nursing pigs ($P > 0.05$). The treatments supplemented live yeast during gestation and lactation (C and D) tended to have lower ADFI during lactation than other treatments (5,406, 5,454, 5,334, 5,103, and 4,931 g/d CON, A, B, C, and D, respectively). The supplementation of live yeast (A, B, C, and D) in the sows' diet was shorter than that of no yeast (CON) on weaning to estrus interval (6.60, 5.14, 5.00, 4.75, and 4.43 days after weaning in CON, A, B, C, and D, respectively, $P < 0.01$). The treatment D had the highest plasma Ig G concentration in piglets at 24 hours of postpartum (7.98, 12.07, 10.15, 11.39, and 20.88 mg/mL, CON, A, B, C, and D, respectively, $P < 0.05$). Consequently, the supplementation of live yeast in sows' diet can improved WEI and plasma Ig G level of nursing pigs although there was few effects reproductive performance.

Key Words: live yeast, sows, reproductive performance

234 Mannan oligosaccharides (Bio-Mos) in diets for sows: Piglet performance and immunity. J. Le Dividich¹, Y. Martel-Kennes², A. Coupel³, and K. Jacques*⁴, ¹INRA, UMR-SENAH, St. Gilles, France, ²Cooperative Research Farms, Richmond, VA, ³Calcialiment, Pleudihen-sur-Rance, France, ⁴Alltech Inc., Nicholasville, KY.

An experiment was conducted to determine the effects of feeding yeast-derived mannan oligosaccharides (Bio-Mos, Alltech Inc.) to sows on colostrum production and IgG (G, A, M) concentrations and on piglet performance and immunity. A total of 100 sows at two sites were used in the study, with an equal number of sows allocated between control (unsupplemented) and test (Bio-Mos) groups. A site in Brittany used mostly P x (LW x LR) sows (n=52; parity 2.9; control or Bio-Mos at 4 g/d). A site in Québec used Canadian Duroc x (LW x LR) sows (n=48; parity 2.9 (control); parity 3.9 (Bio-Mos at 1 kg/T feed)). Measurements included piglet weight at birth, at 24 h and at weaning; sow colostrum production and piglet consumption; IgG concentration (ELISA) in colostrum at birth of the first piglet, and 3, 6, 12 and 24 h thereafter; and IgG concentrations in piglet serum (4 to 6 piglets/litter) at 2 d of age and at weaning (≈ 21 d of age). Data were analyzed using analysis of variance, covariance (parity, litter size, birth weight, weaning age by the parameter analyzed). The site effect was always significant. There was only one significant interaction between site and measured parameters: total number born per litter. Bio-Mos had positive effects on colostrum production (+15%, $P \leq 0.02$) and consumption (+12%, $P \leq 0.04$); litter size (+5.6%, $P \leq 0.09$) and litter weight (+8.5%, $P \leq 0.02$) at weaning; pre-weaning mortality (-35%, $P \leq 0.02$); and IgA concentrations in colostrum (+26%, $P \leq 0.02$) and in piglet serum (at 48 h) (+23%, $P \leq 0.04$). There were no significant effects of Bio-Mos on individual weight of piglets (birth, weaning) or on IgG (G and M) concentrations in colostrum and piglet serum. In conclusion, Bio-Mos added to the sow diet increased consumption of colostrum (and hence energy) and improved quality (IgA) of colostrum and immunity (IgA) of piglets. These improvements likely explain the reduced pre-weaning mortality and larger litter size and weight at weaning observed in litters from supplemented sows. The mechanism(s) by which Bio-Mos

increases piglet consumption of colostrum and IgA concentrations in colostrum remain to be determined.

Key Words: colostrum, sows, mannan oligosaccharides

235 Comparison of estimated body composition of pregnant sows using isotope dilution technique or using live weight and backfat thickness. P. J. L. Ramaekers^{*1}, M. G. H. Veldhorst², P. K. Theil³, and W. J. J. Gerrits², ¹Nutreco Netherlands BV, Boxmeer, the Netherlands, ²Wageningen University and Research Centre, Wageningen, the Netherlands, ³Danish Institute of Agriculture Sciences, Tjele, Denmark.

In total, 24 Hypor sows were used to compare body composition predicted by live weight (LW) and backfat thickness (BF) with that determined by deuterium oxide (D₂O) dilution technique. On d 17 and 57 of gestation, sows received 0.25 g D₂O per kg/LW via the drinking water after 16 h without access to water and feed. Five hours after D₂O supply, blood samples were taken from each sow. LW and BF were measured before D₂O supply and after the 5-h blood sampling. Starting on d 17, sows were assigned to one of two feeding levels based on parity and BF (<17 mm and ≥17 mm). D₂O in serum samples was analysed according to Brand et al. (1996) and body water mass (WM_D) was calculated according to Theil et al. (2002). Equations for Yorkshire x Landrace gilts from Rozeboom et al. (1994) were used to calculate body protein mass (PM_D) from body water mass (WM_D). Equations of Dourmad et al. (1997) were used to calculate body water (WM_B) and protein mass (PM_B) from LW and BF. WM and PM were estimated higher using LW and BF equations than with the D₂O equations (Table 1). Correlations between WM_B and WM_D (0.99) and PM_B and PM_D (0.99) were high. Changes in WM and PM between d 17 and d 57 were lower or similarly estimated with LW and BF compared to D₂O technique (Table 1). Correlations between gained WM_B and WM_D and gained PM_B and PM_D were 0.84 and 0.83, respectively. Although, both methods estimate WM and PM indirectly, our results indicate that the equations of Dourmad et al. (1997) are still valid to estimate WM and PM in modern genotype sows.

Table 1. LW, BF, and water and protein mass and gain estimated from LW and BF or D₂O

		Mean	SD	min	max
Live weight	kg	200	15	160	250
Backfat thickness	mm	17	2	12	20
Water mass LW and BF	kg	103	16	77	133
Water mass D ₂ O	kg	101	18	71	135
Protein mass LW and BF	kg	27.5	5.0	20.1	35.1
Protein mass D ₂ O	kg	25.8	4.2	19.2	32.3
Live weight gain	kg	23	7	12	36
Backfat gain	mm	1.6	1.8	-1.5	5.5
Gain water mass LW and BF	kg	11.4	3.7	5.7	17.9
Gain water mass D ₂ O	kg	13.8	5.2	3.8	21.8
Gain protein mass LW and BF	kg	3.6	1.2	1.7	5.8
Gain protein mass D ₂ O	kg	3.6	1.4	1.0	5.6

Key Words: pigs, body composition, isotope dilution technique

236 Effects of increasing feeding level during late gestation on sow and litter performance. N. W. Shelton^{*1}, J. M. DeRouche¹, C. R. Neill², M. D. Tokach¹, S. S. Dritz¹, R. D. Goodband¹, and J. L. Nelsen¹, ¹Kansas State University, Manhattan, ²PIC, Hendersonville, TN.

A total of 108 gilts and sows (PIC 1050) and their litters were used over 2 parities to determine the effect of increasing late gestation feeding level on sow and litter performance. Treatments were a 2×2 factorial with main effects of feeding level (0 or 0.9 kg of extra feed from d 90 to farrowing) and parity group (gilts or sows). Initial gestation feed levels were based on BW and backfat thickness of a diet containing 3,267 kcal ME/kg and 0.57 % SID Lys. The trial was conducted for 2 successive parities, with females remaining on the same treatment for both parities. For the first parity, increasing feed increased ($P < 0.001$) BW gain from d 90 to 112 (20.5 vs 15.3 kg). Lactation ADFI decreased in gilts (4.5 vs 5.3 kg) and increased in sows (6.10 vs 5.8 kg) with increasing late gestation feed (feeding level × parity interaction $P < 0.004$). Increasing feed in late gestation increased liveborn piglet birth weight in gilts (1.5 vs 1.4 kg), but decreased piglet birth weight in sows (1.4 vs 1.5 kg; feeding level × parity interaction $P < 0.04$). Conception rate after weaning increased in gilts (95 vs 77%), but decreased in sows (88 vs 97%) receiving additional feed in late gestation (feeding level × parity interaction $P < 0.03$). Litter size, litter growth rate, and wean to estrus were not affected ($P > 0.10$) by increasing feeding level. During the subsequent parity, increasing feed level increased lactation backfat and BW loss in parity 2 sows (1.9 vs 0.5 mm; 14.3 vs 5.3 kg), but decreased lactation backfat and BW loss in parity 3 and older sows (0.1 vs 1.2 mm; 5.7 vs 7.3 kg; feeding level × parity interactions $P < 0.02$). Additional feed in late gestation increased liveborn birth weight in parity 2 sows (1.6 vs 1.4 kg) with similar birth weights in parity 3 and older sows (1.4 vs 1.4 kg; feeding level × parity interaction $P < 0.01$). Providing additional feed in late gestation increased ($P < 0.02$) piglet weaning weight (6.4 vs 6.0 kg). Overall, varied responses were found for increased late gestation feeding level in gilts and sows.

Key Words: gestation feeding, lactation, sow

Odor and Nutrient Management

237 Feeding DDGS to swine and resulting impact on air emissions. W. T. Li*, W. J. Powers, and G. M. Hill, *Michigan State University, Department of Animal Science, East Lansing.*

The objective of the study was to evaluate the dietary effects of distillers dried grains with solubles (DDGS) on air emissions by comparing 3 diets, a corn-soybean meal based control diet (C), a diet containing 20% DDGS with inorganic trace mineral sources (20In), and a diet containing 20% DDGS with organic trace mineral sources (20Org). Six pigs were randomly allocated to 1 of 12 environmentally controlled chambers for a 98-d experiment. A total of 72 pigs were blocked into a light BW group and a high BW group to minimize BW variation between and within groups. Concentration and airflow of ammonia (NH₃), hydrogen sulfide (H₂S), nitrous oxide (N₂O), methane (CH₄) and non-methane total hydrocarbons (NMTHC) were measured in exhaust air from each chamber. Body weight gain (BWG) and G:F were not different between rooms fed the different diets, although a lower feed intake ($P < 0.05$) was observed in pigs offered 20Org. Total daily H₂S emission mass was greater in rooms where 20In was offered (462.26 mg) compared to rooms where C (354.62mg) and 20Org (323.10mg) diets were offered. No diet effect was observed when H₂S emissions were adjusted for S consumption (daily mg H₂S emitted·kg⁻¹ S consumed). Compared to C diet, daily mass of NH₃ emitted decreased by 7.6% when pigs were fed 20In and increased by 11.0% in chambers where the 20Org was fed ($P < 0.05$). On a N consumption basis, emission mass from rooms offered the C, 20In and 20Org were 137.56, 124.06 and 161.26 mg·d⁻¹·g⁻¹ N consumed, respectively ($P < 0.01$). Feeding DDGS with either inorganic or organic trace mineral sources increased CH₄ and NMTHC daily emission mass ($P < 0.01$), but not N₂O emissions. Plasma urea nitrogen, albumin, globulin and total bilirubin were not affected by diet. Our results demonstrate that DDGS will increase H₂S, CH₄ and NMTHC emissions from pigs, but organic sources of trace minerals is a promising mitigation strategy to alleviate the adverse effect of DDGS on H₂S emission.

Key Words: DDGS, organic trace mineral source, swine

238 Effects of utilizing dried distillers grains with solubles and phytase in finishing swine. J. W. Bundy*, P. S. Miller, R. Moreno, T. E. Burkey, H. Tran, and E. E. Hinkle, *University of Nebraska, Lincoln.*

A total of 24 barrows was used during a 12-wk period (40 to 120 kg) in order to evaluate the effects of utilizing dried distillers grains with solubles (DDGS), phytase, or the combination of both as alternatives for inorganic P sources. The 12-wk period consisted of 3 dietary phases (40 to 60; 60 to 80; and 80 to 120 kg, respectively). Pigs were individually penned in an environmentally controlled room. Pigs were assigned to 1 of 4 dietary treatments in a completely randomized design. The 4 dietary treatments included: 1) traditional corn-soybean meal with dicalcium-phosphate; 2) traditional corn-soybean meal with 1,000 FTU/kg of phytase and no dicalcium-phosphate; 3) traditional corn-soybean with 20% DDGS inclusion and reduced inclusion of dicalcium-phosphate; 4) a combination of both 20% DDGS and phytase with no dicalcium-phosphate. All diets were formulated to meet or exceed nutrient requirements (NRC, 1998) except for P. Diets without phytase were formulated on an available P basis (0.22, 0.19, and 0.16 %, for the 3

phases, respectively). Diets with phytase were not supplemented with any P in addition to P provided from other feedstuffs. Dietary treatment did not affect ($P > 0.10$) ADG during any of the dietary phases or during the 12-wk period (overall ADG = 0.95 kg). No differences ($P > 0.10$) were observed in feed intake (overall ADFI = 3.09 kg). Subsequently, dietary treatment did not affect ($P > 0.10$) G:F during the experimental period (overall G:F = 0.31). The greatest numerical decrease in feed cost was achieved with the combination of 20% DDGS and 1,000 FTU/kg phytase inclusions for all 3 phases (16.50, 15.18, and 13.64 ;per 1,000 kg less than the traditional corn-soybean meal with dicalcium phosphate diet based on August 2008 prices for the 3 phases, respectively). These results suggest that there are methods to reduce or replace the use of calcium-phosphates in finishing swine without affecting feed intake, growth rate, or feed efficiency.

Key Words: dried distillers grains with solubles, phosphorus, phytase

239 Digestibility of inorganic phosphorus and efficacy of OptiPhos phytase in lactating sows. N. L. Horn*¹, M. L. Roux¹, N. R. Augspurger¹, and B. W. Ratliff², ¹JBS United, INC., Sheridan, IN, ²Enzyvia, LLC., Sheridan, IN.

Inorganic phosphorus (P) digestibility and OptiPhos efficacy were investigated in lactating sows. Seventy-two multiparous sows were allotted in a randomized complete block design to six dietary treatments on the basis of parity and body weight at the time of entry into the farrowing room. The dietary treatments were corn-soybean meal-based and consisted of: negative control (NC) (Trt 1), NC + 0.10 % P from monocalcium phosphate (Trt 2), NC + 0.20 % P from monocalcium phosphate (Trt 3), NC + 0.30% P from monocalcium phosphate (Trt 4), NC + 250 FTU OptiPhos/kg (Trt 5), NC + 1,000 FTU OptiPhos/kg (Trt 6). Chromic oxide served as an indigestible marker. Sows were fed a common lactation diet from d 0 to 4 of lactation. Experimental diets were fed ad libitum from d 5 to 13 with a 6-d adaptation period followed by a 3-d collection period. Fecal samples were collected daily by rectal palpation and pooled for analysis. The digestibility coefficients for total dietary P were calculated according to the index method. The digestibility of P in monocalcium phosphate was determined by regression, where absorbed P (g/d) was regressed as a function of supplemental P intake (g/d), resulting in the following equation: $Y = 0.656 (SE = 0.059) \times (\text{supplemental P intake [g/d]}) - 38.94 (SE 5.94), r^2 = 0.75$. Digestibility of P from monocalcium phosphate was not affected by dietary inclusion rate ($P > 0.05$). Apparent P digestibility increased ($P < 0.05$) from 27.21 to 37.1, 42.1, and 45.1% as 0.10, 0.20, and 0.30% P was added to the diets, respectively. Apparent P digestibility was increased ($P < 0.05$) by 14.1 and 27.2%-points with the addition of 250 and 1,000 FTU OptiPhos/kg, respectively. These data show the digestibility of P from feed-grade monocalcium phosphate to be 65.6% in multiparous lactating sows. Supplementation of 250 or 1,000 FTU OptiPhos/kg result in the release of 0.054 and 0.103% digestible P, respectively. Understanding inorganic P digestibility is critical to accurately valuing the P-releasing potential of phytases and their use in sow diets.

Key Words: phosphorus digestibility, phytase, sow

240 Stability of various commercial phytase sources. C. K. Jones^{*1}, M. D. Tokach¹, R. D. Goodband¹, S. S. Dritz¹, D. R. Campbell², B. W. Ratliff³, J. M. DeRouchey¹, and J. L. Nelssen¹, ¹*Kansas State University, Manhattan*, ²*DSM Nutritional Products, Inc., Parsippany, NJ*, ³*Enzyvia, LLC, Sheridan, IN*.

A 180-d trial evaluated the effects of environmental conditions on phytase stability. Coated and uncoated products from 3 phytase sources (Ronozyme P, OptiPhos, and Phyzyme) were stored as pure form, in a vitamin premix, or in a vitamin and trace mineral (VTM) premix. Pure forms were stored at -18, 5, 23, and 37°C (75% humidity). Premixes were stored at 23 and 37°C. All treatments were sampled on d 0, 30, 60, 90, and 120. Treatments stored at 23 or 37°C were also sampled on d 180. All factors studied influenced stability (source × form × temperature × coating × time interaction; $P < 0.001$). When stored at 23°C or less, temperature did not influence phytase stability; however, 37°C was detrimental to stability of all phytase sources and forms, with coated OptiPhos being the least affected. Phytase activity of pure products decreased at each sampling period (d 30, 60, 90, 120, and 180) with greater activity remaining on each d for phytase stored at 23°C (>100, >100, 97, 89, and 86%, respectively) than 37°C (72, 50, 46, 39, and 29%, respectively). When stored in pure form at 23°C, phytase activity remaining at d 180 was >84% for all phytase sources except uncoated Ronozyme P (61%). At 37°C, coating increased phytase activity remaining at d 180 for OptiPhos (53 vs. 39%) and Ronozyme P (15 vs. 3%), but not Phyzyme (21 vs. 43%) relative to their uncoated pure form. When added to vitamin premixes and stored at 23°C, coating increased activity remaining on d 180 for OptiPhos (94 vs. 76%), Ronozyme P (94 vs. 73%) and Phyzyme (87 vs. 67%) compared with their uncoated form. The response was similar for VTM premixes with more activity remaining on d 180 for the coated forms (OptiPhos, 70 vs. 43%; Ronozyme P 76 vs. 64%; Phyzyme, 92 vs. 60%). Similar to pure phytase, exposing premixes to 37°C greatly decreased phytase activity on d 180 with coated OptiPhos having more activity remaining (41%) than other phytase sources. In conclusion, pure products held at 23°C or less were the most stable. In premixes, longer storage time and higher temperature reduced phytase activity, but coating mitigated some of these negative effects.

Key Words: enzyme, phytase, stability

241 Dietary calcium and phosphorous and organic and inorganic minerals on mineral digestibility in swine. J. S. Jolliff^{*} and D.C. Mahan, *The Ohio State University, Columbus*.

Calcium and P levels and trace mineral supplements were evaluated for their role in mineral digestibility. Two levels of Ca and P (Ca:P) and 3 trace mineral (TM) treatments (2 × 3 factorial) were analyzed over 6 replicates in growing pigs (55 kg BW). The 2 Ca:P levels were 0.65% Ca and 0.55% P (LOW) and 1.00% Ca and 0.85% P (HIGH). The 3 TM treatments were: 1) No supplemented TM, i.e. all minerals were considered indigenous (BASAL); 2) Organic TM supplied as soy protein chelates (ORG); and 3) Inorganic TM supplied as mineral salts (INORG). Both ORG and INORG supplements added 10 ppm Cu, 150 ppm Fe, 10 ppm Mn, and 140 ppm Zn to the BASAL diet. Following a 14 d acclimation period in metabolism crates, total fecal excretion was collected for 10 d. BASAL diets contained approximately 34% of the TM levels in the ORG and INORG supplemented diets. Apparent digestibility of dietary minerals and total fecal mineral excretion were affected by both Ca:P and TM. LOW Ca:P diets resulted in greater % apparent digestibility of Ca, Cu, Fe, and Zn ($P < 0.01$), but not Mn or

P, than the HIGH Ca:P diets. Both Cu ($P < 0.05$) and Mn ($P < 0.05$) had greater digestibility in the ORG diets than the INORG diets. In contrast, Zn was more ($P < 0.05$) digestible in the INORG than the ORG supplemented diets. Fecal excretion of Ca and P was greater ($P < 0.01$) with HIGH Ca:P, but was unaffected by TM source. Total fecal excretion of Cu, Fe, Mn, and Zn was less ($P < 0.05$) when the BASAL diet was fed than the ORG or INORG supplemented diets. There were no Ca:P × TM interactions for either % apparent digestibility or total fecal mineral excretion of macro- and microminerals. Our results indicate that increased Ca:P supplementation reduced micromineral digestibility. Also ORG TM have a greater % Cu and Mn apparent digestibility than INORG minerals while INORG Zn was more digestible. The greater Ca:P levels had similar effects on the digestibility of both ORG and INORG TM supplements.

Key Words: pigs, minerals, digestibility

242 Effects of dietary biotite supplementation and stocking density on growth performance, nutrient digestibility, blood characteristics and fecal odor emission in growing pigs. H. J. Kim^{*}, J. H. Lee, Q. W. Meng, B. W. Yang, and I. H. Kim, *Dankook University, Department of Animal Resource and Science, Cheonan, Choongnam, Korea*.

A 2×3 factorial (biotite supplementation, three regimens of stocking densities; 1.08, 0.81 and 0.65 m²/pig) arrangement was used with 96 crossbreed pigs [(Landrace×Yorkshire)×Duroc, avg. BW 19.60 kg]. The diet was supplemented with 0.3% biotite. The experiment lasted for 42 days. Each treatment had 4 replicates. Average daily gain and average daily feed intake were improved by increasing stocking density ($P < 0.001$). However, G/F ratio had no significant difference among treatments. No significant difference was observed on nutrient digestibility containing dry matter and nitrogen. In blood characteristics, white blood cell concentration at final sampling period was significantly decreased ($P < 0.01$) by increasing stocking density. Red blood cell concentration at final sampling period was significantly decreased ($P < 0.001$) by supplementing biotite. However, cortisol concentration at final sampling period was decreased ($P < 0.05$) by supplementing biotite. In fecal odor emission, total mercaptans and ammonia concentration at 5 days and 10 days were significantly decreased (5 days total mercaptans and ammonia at 5 days, $P < 0.01$ and $P < 0.05$; total mercaptans and ammonia at 10 days, $P < 0.01$) by supplementing biotite. In conclusion, dietary biotite supplementation improved the immunity of growing pigs as stocking density increased. Likewise, fecal odor emission can be effectively reduced by supplying biotite.

Key Words: biotite, stocking density, growing pigs

243 The effects of fly ash supplementation on growth performance, nutrient digestibility, meat quality and fecal concentration of gases in finishing pigs. L. Yan^{*}, D. L. Han, Q. W. Meng, T. X. Zhou, and I. H. Kim, *Dankook University, Department of Animal Resource and Science, Cheonan, Choongnam, Korea*.

Forty-eight [(Landrace Dankook University × Yorkshire) × Duroc] pigs with an average initial body weight (BW) of 48.47 ± 1.13 kg were used in a 12-week growth trial to investigate the influence of fly ash-based zeolites (FAs) supplementation on growth performance, nutrient digestibility, meat quality and fecal concentration of gases in finishing

pigs. Pigs were allotted into three dietary treatments in a randomized complete block design according to sex and initial BW. Each dietary treatment consisted of 4 replications with 4 pigs per pen. Dietary treatments included: 1) control (CON; basal diet), 2) HC1 (CON + 0.3 ppm FAs), 3) HC2 (CON + 0.6 ppm FAs). No significant differences were observed in ADG, ADFI and G/F among groups throughout the experiment. The ADFI tended (quadratic $P = 0.05$) to be higher in pigs fed FAs supplemented diets compared with CON group during weeks 6 to 12. The coefficient of total tract apparent digestibility (CTTAD) of dry matter (DM), nitrogen (N) and energy responded to FAs supplementation in a quadratic ($P < 0.05$) manner. Increased meat firmness ($P = 0.015$) was observed in response to FAs supplementation. FAs supplementation tended to increase meat color and decrease the level of 2-Thiobarbituric acid reactive substances (TBARS) ($P = 0.051$). Furthermore, providing pigs with diets supplemented with FAs led to a significant (Linear, $P = 0.02$) decrease in the fecal NH₃ when compared with the CON. The fecal H₂S concentration was lower ($P = 0.06$) in the groups that received diets supplemented with FAs at 0.3 mg kg⁻¹ when compared to the CON. Overall, supplementation of the diet with 0.3 mg kg⁻¹ FAs was found to exert a beneficial effect on the nutrients digestibility and meat quality of finishing pigs, while concomitantly decreasing the noxious gas emission without having a negative effect on growth performance.

Key Words: fly ash, growth performance, finishing pigs

244 Effects of cattle presence on sediment, phosphorus, and pathogen loading of streams in cool-season grass pastures. K. A. Schwarte*, J. R. Russell, S. Ensley, K. J. Yoon, and D. G. Morrical, *Iowa State University, Ames.*

An experiment was conducted to monitor the effects of cattle presence on the amount of sediment, phosphorus, and pathogen loading of streams

flowing through cool-season grass pastures during the 2008 grazing season. Six 12.1-ha pastures, primarily containing smooth brome grass and bisected by a 141-m stream reach, were stocked with 15 fall-calving Angus cows and grazed by continuous stocking with unrestricted stream access (CSU), continuous stocking with stream access restricted to 4.9-m wide stabilized crossings (CSR), or rotational stocking (RS). Rainfall simulations were conducted in June, August, and October of 2008 at six vegetated and six bare sites along the stream banks in CSU and RS pastures and six vegetated sites along the stream banks of CSR pastures. At each site, simulated rainfall was applied to 0.5 m² using drip-type simulators at a rate of 8.4 cm/hr for 1.5 hr. All runoff was collected, recorded, and analyzed for the concentrations of sediment and phosphorus and the presence of *Escherichia coli* O157:H7, Bovine Enterovirus, Bovine Coronavirus, and Bovine Rotavirus. Bare areas on stream banks had greater amounts of runoff and phosphorus losses in runoff than vegetated areas ($P < 0.05$) across grazing management treatments. Bare areas in both CSU and RS pastures had greater ($P < 0.05$) sediment losses in the runoff than vegetated areas of CSR pastures. *Escherichia coli* O157:H7, Bovine Coronavirus, and Bovine Rotavirus were not detected in any runoff samples. However, Bovine Enterovirus was detected 8.3% and 16.7% of the runoff samples from bare areas in CSU pastures in June and October, respectively. Results suggest that managing grazing to minimize the amount of bare area near streams can reduce the risks of sediment, phosphorus, and pathogen loading of pasture streams.

Key Words: grazing management, surface runoff, riparian buffer

Physiology

245 (Invited ADSA Young Dairy Scholar) Progesterone clearance in dairy cows fed an insulin stimulating diet. C. O. Lemley*¹, L. R. Tager¹, T. A. Wilmoth¹, K. M. Krause¹, K. A. Vonnahme², and M. E. Wilson¹, ¹*West Virginia University, Morgantown,* ²*North Dakota State University, Fargo.*

In dairy cows the high metabolic demand attributed to selection for milk yield has had negative ramifications on reproductive performance. Progesterone (P4) is required for maintenance of pregnancy and low P4 concentrations may lead to lowered fertility. The cow *corpus luteum* produces approximately 250 to 500 mg of P4 a day. More than 50% of P4 will be inactivated in the liver by cytochrome P450 2C (CYP2C) and 3A (CYP3A) enzymes. Previously our laboratory demonstrated that an insulin stimulating diet decreased P4 clearance in sheep and decreased hepatic CYP2C and CYP3A activity. Utilizing a hepatocyte cell line we determined that increasing physiological concentrations of insulin caused a dose-dependent decrease in P4 decay as well as CYP2C and CYP3A activity; therefore, we hypothesized that elevated insulin led to lower cytochrome P450 activity, which caused a decrease in P4 catabolism. In two separate experiments, dairy cows were fed a diet

containing 23.1% soybean hulls (high fiber diet; HF) or an isoenergetic and isonitrogenous ration containing 15.1% cornstarch (high cornstarch diet; CS). Milk yield was similar, while energy balance was improved in cows consuming CS versus HF. Average insulin concentrations were elevated by 25% in cows consuming CS compared to HF. Liver biopsies were taken at 3 or 4 hours post-feeding and hepatic cytochrome P450 activity was decreased by approximately 40% in cows consuming CS. Progesterone half-life at 3 hours post-feeding tended to be longer, while P4 half-life at 4 hours post-feeding was nearly 3 fold longer in cows consuming CS versus HF. Liver blood flow was not different between the two diets; however, the metabolic clearance rate of P4 at 1 to 4 hours post-feeding tended to be 36% lower in cows consuming CS versus HF. Significant positive correlations were found between insulin concentrations, energy balance and P4 half-life. Feeding diets that stimulate insulin secretion appear to decrease P4 clearance, which may improve fertility and embryonic survival in dairy cows.

Key Words: P4 clearance, insulin, cytochrome P450

246 (Invited ASAS Animal Science Young Scholar) Factors affecting ovulatory follicle size, embryo quality and pregnancy in suckled beef cows. J. A. Atkins^{*1}, M. F. Smith¹, and T. W. Geary², ¹University of Missouri, Columbia, ²USDA-ARS, Fort Keogh Livestock and Range Research Laboratory, Miles City, MT.

Ovulation of small dominant follicles resulted in reduced pregnancy rates compared to cows that ovulated large follicles. Reasons for the presence of a small dominant follicle at the time of GnRH-induced ovulation and mechanisms by which follicle size affects pregnancy outcome have been a focus of our laboratories. Two experiments were conducted to study the occurrence of small follicles at time of ovulation induction in cycling (n=60) and anestrus (n=55) suckled beef cows. All cows were treated with the CO-Synch protocol (GnRH1 on d -9, PGF_{2α} on d -2, and GnRH2 on d 0). Follicle growth rate leading up to GnRH2 was similar between cows that ovulated a large or small follicle in both cycling and anestrus cows (P = 0.75 and 0.99, respectively). Cyclic cows on d 5, 9, 13, or 18 of the estrous cycle that ovulated in response to GnRH1 had larger follicles at GnRH2 compared to cows that did not ovulate to GnRH1 (11.4 and 9.5 mm, respectively; P = 0.04). Similarly, anestrus cows that ovulated following GnRH1 had larger follicles at GnRH2 compared to cows that did not ovulate after GnRH1 (12.3 vs. 11.0 mm, respectively; P = 0.04). In the third experiment, the relationship between ovulatory follicle diameter, CL function, and embryo quality 7 d after GnRH2 and AI were monitored. Suckled beef cows (n=931) received the CO-Synch protocol and embryos or unfertilized oocytes (n=356) were recovered 7 d after AI in a portion of the cows (n=644). Follicle size at GnRH2/AI was positively correlated with CL volume and serum concentrations of progesterone 7 d after AI (r = 0.45 and 0.29, respectively; P < 0.001) and tended to improve embryo quality (P = 0.09). In summary, ovulation to GnRH1 increased follicle diameter at GnRH2. Cows that ovulated a large follicle had increased serum concentrations of progesterone, CL volume, and tended to have better quality embryos 7 d after AI.

Supported by NRI grant 2006-35203-17284 from USDA-CSREES.

Key Words: follicle diameter, beef cattle, embryo quality

247 Effects of nutritional plane and dietary selenium during gestation on serum prolactin and estradiol-17β (E₂) in ewe lambs during pregnancy and lactation. L. E. Camacho^{*1}, A. M. Meyer¹, D. M. Hallford², G. Perry³, L. P. Reynolds¹, J. S. Caton¹, and K. A. Vonnahme¹, ¹Center for Nutrition and Pregnancy, Dept. of Animal Sciences, North Dakota State University, Fargo, ²Department of Animal & Range Sciences, New Mexico State University, Las Cruces, ³Department of Animal & Range Sciences, South Dakota State University, Brookings.

To examine effects of nutritional plane and Se supply during pregnancy on serum PRL and E₂ profiles throughout gestation and early lactation, Rambouillet ewe lambs (240 ± 17 d; n = 42) were randomly assigned to a 2 × 3 factorial arrangement. Treatments included adequate Se (ASe, 11.5 µg/kg BW) or high Se (HSe, 77 µg/kg BW) initiated at breeding (d 0) and 60% (RES), 100% (CON), or 140% (HIGH) of NRC initiated at d 40 of gestation. At parturition lambs were removed, and ewes were transitioned to a lactating diet supplying 100% requirements and adequate Se. Blood samples were collected during gestation (39, 53, 67, 81, 95, 109, 123, 137, 144, 151 d), parturition (152 d; 0, 3, 6, 12, 24 h), and lactation (153, 159, 166, 172 d) to determine PRL and E₂ concentrations. A nutrition by day interaction (P = 0.01) was detected for PRL during gestation. On d 53 and from d 137 through the remain-

der of pregnancy, HIGH ewes had greater (P < 0.05) PRL compared to CON and RES. At parturition (d 151) CON and HIGH ewes had greater PRL (P = 0.05) than RES ewes. During parturition, PRL tended to be higher (P = 0.06) in CON and HIGH ewes compared to RES ewes. Throughout lactation, PRL concentrations were greater (P ≤ 0.01) in HIGH compared to CON and RES ewes. For E₂, ASe-RES ewes had greater (P < 0.05) concentrations from d 53 to 109 compared to all other treatments (Nut × Se × d, P = 0.04). While there was no difference in E₂ concentrations among RES, CON, and HIGH ewes throughout the parturition period, E₂ was elevated (P = 0.01) at 0 h (≈130 pg/mL) and then gradually declined to less than 10 pg/mL within 24 h. During lactation E₂ concentrations were greater (P = 0.05) in RES ewes compared to CON, which were greater than (P < 0.05) HIGH ewes. Gestational diet did not alter E₂ for the remainder of lactation. Despite similar lactation diets, gestational nutritional plane and Se supply affected PRL and E₂ concentrations during pregnancy, parturition, and lactation, potentially affecting the differences observed in mammary gland development and milk production.

Key Words: gestational nutrition, prolactin, estradiol-17

Abstract 248 Withdrawn

249 Myelination is decreased in the brain stem of small piglets compared to larger littermates during late gestation. J. L. Vallet^{*} and J. R. Miles, USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.

Prewaning mortality is associated with low birth weights. Reduced myelination in the brain of low birth weight piglets has been reported, however, these studies measured brain cholesterol, which is not myelin. Thus, we compared myelination in brain regions associated with coordinated movement and reflexes during late gestation. Gilts were mated at estrus, and four gilts each were killed on days 92, 100, and 110 of gestation. Cerebellar, brain stem and spinal cord tissues were obtained from the largest and smallest fetus in each litter. Myelin basic protein (MBP) mRNA was quantified in each tissue using real time rtPCR. Myelin was recovered from each tissue by differential centrifugation, and was then subjected to SDS-PAGE and TLC to examine MBP and lipids, respectively. MBP mRNA increased with advancing gestation in all three tissues examined (P ≤ 0.05), and was decreased in brain stem of small piglets compared to large piglets (P < 0.01). Two major coomassie stained protein bands corresponding to myelin basic proteins (HMWMBP and LMWMBP, respectively, confirmed by immunoblotting) were observed by SDS-PAGE. Six prominent lipid bands were obtained by TLC. Protein and lipid bands were quantified using densitometry. The MBP and lipid bands obtained from brain stem increased with advancing day of gestation (P ranging from < 0.1 to < 0.0001) and were decreased in brain stems of small piglets compared to the large piglets (P ranging from < 0.1 to < 0.01). Significant day by fetal size interactions (P < 0.1 to P < 0.01) for MBP and lipid bands from cerebellum indicated that cerebellar myelination in the smallest fetuses was decreased compared to the largest fetuses on day 100 of gestation but recovered by day 110. Myelination in spinal cord increased with day of gestation (P < 0.05 to P < 0.0001 for MBP and lipids) and was not different between smallest and largest fetuses. These results confirm that myelination of brain regions, but not spinal cord, of small piglets is decreased compared to large littermates during late gestation with brain stem being most affected.

Key Words: myelin, cerebellum, pregnancy

250 Timed insemination following GnRH agonist administration in weaned sows. M. E. Johnston^{*1}, A. M. Gaines², M. E. Swanson¹, and S. K. Weibel¹, ¹*JBS United Inc., Sheridan, IN*, ²*The Maschhoffs, Carlyle, IL*.

The objective of this study was to determine the effect of a single, fixed timed insemination following GnRH administration on subsequent farrowing rate and litter size. Three hundred weaned sows (PIC) were blocked by parity (parities 1 through 6; average parity 2.8), previous lactation length (range 17 to 25 d; average length 21 d), and body condition score (range 2.5 to 3.5; average score 2.8) and allocated to one of two treatments. Control sows were observed for 7 d after weaning for behavioral estrus and inseminated the day they were observed in estrus and at 24 h intervals for the duration of estrus. Sows in the GnRH treatment group (GnRH sows) were also observed for 7 d after weaning for signs of behavioral estrus but were treated intravaginally with a proprietary GnRH agonist preparation (OvuGel) on d 4 after weaning and then inseminated once 24 ± 2 h post-OvuGel treatment, regardless of whether or not they showed signs of standing estrus. Of the 150 Control sows 80.7% (121) were bred by 7 d post-weaning compared to 100% (150) of the GnRH sows ($P < 0.01$). Control sows averaged 2.3 inseminations per sow while GnRH sows all had 1 insemination per sow ($P < 0.01$). There was no difference ($P > 0.40$) in number of sows farrowing between Control and GnRH sows, 72.7% (109 sows) and 76.7% (115 sows), respectively. There was no effect of treatment on number of stillborns ($P > 0.30$) and mummies ($P > 0.45$). GnRH sows farrowed an average of 11.3 pigs born alive compared to 10.9 pigs born alive to Control sows ($P < 0.37$). Pigs born per semen dose was 5.6 vs. 9.6 ($P < 0.01$) for Control and GnRH sows, respectively. These data indicate that treating sows with the proprietary GnRH agonist, OvuGel and inseminating once with respect to the time of GnRH treatment results in farrowing rates and litter sizes comparable to sows receiving multiple inseminations during behavioral estrus.

Key Words: sow, reproduction, GnRH

251 Effect of gonadotropin treatment on estrus, ovulation and litter size in weaned sows. R. Manjarin^{*1}, J. C. Garcia⁴, J. C. Dominguez⁴, M. J. Castro⁴, B. Alegre⁴, J. D. Munoz³, N. Trotter¹, and R. N. Kirkwood², ¹*Michigan State University, Departments of Animal Science, East Lansing*, ²*Michigan State University, Large Animal Clinical Sciences, East Lansing*, ³*Michigan State University, Crop and Soil Science, East Lansing*, ⁴*University of Leon, Medicine, Surgery and Veterinary Anatomy, Campus de Vegazana, Spain*.

This experiment was performed to evaluate estrus, ovulation, and litter size of sows receiving PG600 at weaning with supplemental hCG. At weaning 247 Hypor sows were assigned by parity (1 and 2 or ≥3) to receive an intramuscular injection of 400 IU eCG plus 200 IU hCG (PG600), or PG600 supplemented with 100 IU hCG injected either concurrently (100-hCG-0) or after 24 h (100-hCG-24), or 200 IU hCG after 24 h (200-hCG-24) or serve as non-injected controls. Sows were boar exposed for 15 min daily for 7 d. Following treatment of parity 1 and 2 sows, all gonadotropin groups increased ($P < 0.05$) the estrus detection rate compared to the control group, whereas farrowing rate was increased ($P < 0.05$) only in the PG600, 100-hCG-24 and 200-hCG-24 groups. Following treatment of parity ≥3 sows there was no treatment effect on the estrus response. PG600 and 100-hCG-24 increased ($P < 0.05$) farrowing rate compared to the 200-hCG-24, 100-hCG-0 and control sows. There was no effect of treatment or parity on subsequent

litter size. These data suggest that hCG treatment subsequent to PG600 treatment does not improve fertility in weaned sows.

Key Words: sow, anestrus, PG600

252 Retrospective analysis of factors affecting sperm production/quality measures in a boar stud. T. J. Safranski and A. T. Desaulniers*, *University of Missouri, Columbia*.

The vast majority of sows being mated artificially with semen from an off-farm stud renews the need to study factors influencing sperm production and quality. Data from 45,131 ejaculates, 1,172 boars, and five genetic lines from April 3, 2006- September 17, 2009 were used to study factors affecting sperm production and quality measures. Ejaculate characteristics analyzed as dependent variables included: volume, concentration, total cells, motility, progressive motility, percentage normal heads (%NHD) and tails (%NTL), and velocity traits from CASA analysis (VSL, straight line; VAP, average path; VCL, curved line; all microns/sec). A model including genetic line, sire(line) as the error term, age at collection, month of collection, year of collection and month of birth was fitted. Age at ejaculation had the largest mean square for all traits analyzed. All model effects were significant at $P = 0.01$ or less for all traits. Models had R-squares of 0.38 to 0.55 except %NHD and %NTL which were 0.13 and 0.16, respectively. Month of collection showed seasonal patterns for most traits: e.g. LSM ± SE for progressive motility from 75.05±1.25% in August to 83.89±1.27% in April; concentration from 0.359±0.024 in August to 0.411±0.024 million/mL in April. Objectively determined velocities also peaked in April and reached their nadir in August or September. Essentially all traits showed improvement over time, (e.g. %NTL 90.64±1.16, 94.43±1.06, 95.84±1.02 and 97.28±1.03 over four years) indicating improved genetics or management. Birth month was fit in light of data demonstrating impact of in utero and neonatal environment on reproductive performance of pigs. While statistically significant, the effect was clearly less dramatic than other variables in the model, and it is not possible to determine whether effects were from in utero or extrauterine environment. Additionally, seasonal patterns were not as clear for many traits. Additional data sets and analyses are prudent to further study the impact of season of birth on production variables.

Key Words: boar, sperm production, environment

253 (Invited) Factors affecting the formation of the maternal:placental interface in the pig. J. W. Ross^{*1}, M. D. Ashworth², R. D. Geisert³, and F. J. White⁴, ¹*Iowa State University, Ames*, ²*Yale University, New Haven, CT*, ³*University of Missouri, Columbia*, ⁴*Cameron University, Lawton, OK*.

The formation of an effective maternal:placental interface is essential to the establishment and maintenance of pregnancy in the pig. Interactions between the conceptus trophoblast and the uterine endometrium are required for the development of an *epitheliochorial placenta*. Two major contributors to this process include the regulation of conceptus trophoblastic elongation and the receptivity of the uterine endometrium to conceptus trophoblast attachment. While trophoblastic elongation and uterine receptivity represent distinct conceptus and maternally driven processes, there is a dynamic conceptus-uterine interplay essential for conceptus development and placental attachment. Trophoblastic elongation occurs concomitantly with the transient conceptus synthe-

sis and secretion of estrogen and interleukin 1-beta (IL1B). Estrogen, the maternal recognition of pregnancy signal in the pig, prolongs the lifespan of the corpora lutea and transforms endometrial function. IL1B secretion by the conceptus occurs during a transient, pregnancy specific up-regulation of IL-1 receptors in the uterine endometrium and the endometrial response to IL1B can be modulated by estrogen. IL-1 receptor activation can result in activation of transcription factors, such as nuclear factor kappa B (NFkB). Interestingly, endometrial expression of NFkB regulated genes increase during days 10-15 in both cyclic and pregnant gilts, more closely patterning the loss of progesterone receptor (PR) expression in the luminal and glandular epithelium. Conceptus elongation coupled to the synthesis and release of estrogen and IL1B may function through coordinated mechanisms to influence endometrial receptivity to the conceptus following the down-regulation of PR in the luminal and glandular epithelium. Following the decline in conceptus IL1B, endometrial release of IL18 may play a role in placental growth and attachment during early pregnancy. Understanding the molecular mechanisms by which the pig conceptus and the uterine endometrium interact during pregnancy establishment is critical to developing strategies for improving the formation of an efficient maternal:placental interface.

Key Words: conceptus, endometrium, pig

254 (Invited) Modification of the early gestational environment can have long term consequences on conceptus growth and development. M. E. Wilson*, T. A. Wilmoth, and J. M. Koch, *West Virginia University, Division of Animal and Nutritional Sciences, Morgantown.*

Considerable evidence has been uncovered linking alterations in the gestational environment to long term consequences for the physiology and health of individuals. The preponderance of this evidence has been from late-gestation experimental paradigms that modify conceptus development and include nutrient restriction to the dam and treatments to reduce placental function. Evidence is emerging that modifications to maternal physiology during early- to mid-gestation can also have impacts on conceptus development. In the pig, the amount of estradiol produced at the time of maternal recognition of pregnancy and embryo elongation has been associated with the size of the embryo at elongation. Providing exogenous estradiol at the time of elongation can dramatically increase proliferation of the trophoblast and result in an increase in the size and weight of the placenta at the term of gestation nearly 100 days later. In sheep, treatment of ewes with exogenous, sustained-release growth hormone at the time of breeding can increase plasma IGF-I concentrations as much as 400% for the first month of pregnancy. By about the third month of gestation this treatment will have altered placental growth and expression of several placental nutrient transporters. This effect of growth hormone in the first one-fifth of pregnancy has been demonstrated to increase birth weight, body composition, cardiac development and hepatic expression of both the growth hormone receptor and IGF-I at birth. In addition, the increase in body weight observed at birth is maintained through approximately the first 100 days of life and results in a reduced sensitivity of the hypothalamic-hypophyseal-hepatic growth hormone-IGF-I axis to an exogenous challenge with growth hormone releasing hormone. Given the considerable amount of development and differentiation of organ systems that occur in utero it is not surprising that modifications of the conceptus environment at any point during gestation have potential to dramatically impact conceptus development.

255 (Invited) The role of placental programming in life-long health and productivity. L. P. Reynolds*, P. P. Borowicz, J. S. Luther, C. J. Hammer, K. R. Maddock Carlin, A. T. Grazul-Bilska, J. S. Caton, D. A. Redmer, and K. A. Vonnahme, *North Dakota State University, Fargo.*

'Developmental programming' is the concept that altered growth and development of the fetus or neonate can have long-term consequences for the offspring, thereby affecting life-long health and productivity. This concept has been confirmed with epidemiological studies as well as controlled studies in numerous mammalian species, including livestock. Various factors can alter the fetal or neonatal growth trajectory, including maternal nutrient deprivation or excess, maternal environmental stress, maternal exposure to steroids, etc. This symposium talk will focus on maternal age as well as maternal and fetal breed in the context of developmental programming. It also will address emerging concepts in developmental programming, with a particular focus on the role of 'placental programming' in altered fetal growth and development. By more completely understanding the factors responsible for developmental programming, we hope to develop strategies to minimize its negative consequences for livestock production.

256 Effect of *Saccharomyces cerevisiae* fermentation products on growth of *Lactobacillus acidophilus* in vitro. D. Severson*, I. Yoon, J. Butler, and M. Scott, *Diamond V, Cedar Rapids, IA.*

Presence of *Lactobacillus acidophilus* in the gastrointestinal (GI) tract has been shown to provide various health benefits to the host animal. As a result, prebiotic feed additives have been tested for their ability to stimulate the growth of *L. acidophilus* in the GI tract. An in vitro model was used to investigate the effect of *Saccharomyces cerevisiae* fermentation products (XP and XPC; Diamond V Original XP and XPC) on growth of *L. acidophilus* ATCC 43121. *Lactobacillus* cultures were grown overnight at 37°C in complete MRS medium. Cultures were washed twice with sterile 0.9% saline and resuspended in 0.9% saline to an optical density (OD) of 5.0 at 660 nm. Microtiter plate wells containing modified MRS medium were inoculated with *L. acidophilus* to an initial OD of 0.05, sealed to restrict oxygen, and incubated at 37°C for 5 hours with shaking in a BioTek Synergy HT plate reader. Modified MRS medium did not contain yeast extract (YE) and beef extract. Instead, YE was used as a reference standard. Treatments were added at various inclusion rates; 0, 0.5, 1.0, 2.0 and 4.0 g/L for XP; 0, 0.125, 0.25, 0.5 and 1.0 g/L for XPC; and 0, 1.0, 2.0, 4.0, 6.0 and 8.0 g/L for YE. Optical density readings were conducted every 15 minutes for 5 hours. Assays were repeated 5 times (n = 5). The growth of *L. acidophilus* was dose dependent and increased linearly ($P < 0.05$) as the concentration of YE, XP and XPC increased. Addition of XP and XPC increased ($P < 0.05$) the growth of *L. acidophilus* compared to YE. Slopes of growth stimulation as a function of treatment concentration were 0.052, 0.081 and 0.301 for YE, XP and XPC, respectively. Effect of XPC was approximately 4 times greater than XP when compared at equal inclusion rates, which corresponds to the difference in recommended feeding rates. Results suggest that dietary supplementation of XP or XPC could be an effective tool for stimulating the growth rate of *L. acidophilus* in the GI tract.

Key Words: *Saccharomyces cerevisiae* fermentation product, *Lactobacillus acidophilus*, in vitro

257 *Saccharomyces cerevisiae* fermentation product and a fermentation prototype stimulate bacterial production of butyrate in vitro with swine fecal inoculum. D. Severson*, I. Yoon, J. Butler, and M. Scott, *Diamond V, Cedar Rapids, IA.*

Butyrate, a short-chain fatty acid produced during bacterial fermentation of dietary nutrients, has been found to influence the inflammatory response, inhibit pathogens, improve intestinal morphology, reduce diarrhea and be a primary energy source for intestinal cells resulting in improved growth performance and feed efficiency in nursery pigs and broilers. In vitro assays, using fresh fecal inoculum from sows (30 g wet feces/220 ml phosphate buffer), were performed to investigate the effects of *Saccharomyces cerevisiae* fermentation product (XPC; Diamond V Original XPC) and a fermentation prototype (FP; Diamond V) on bacterial production of butyrate. Predigested (pepsin-pancreatin) corn/soy (3:1), wheat/barley (1.35:1) and corn/soy/DDGS (2:1:1) mixtures were used as substrates (10 g/L) in a series of assays. Treatments were tested at 5 g/L and incubations were performed at 39°C for 12 or 24 hours (n = 5). All transfers, handling, and incubations were conducted under strict anaerobic conditions. Butyrate production was increased ($P < 0.05$) by XPC and FP on all substrates tested compared with control (Table 1). The effect of FP was greater ($P < 0.05$) than XPC on all substrate types at both incubation times. Results suggest that both XPC and FP may stimulate bacterial production of butyrate with various feed ingredients typical of swine and poultry production.

Table 1. Effect of XPC and FP on butyrate production (mM) in vitro¹

Substrate	12 h				24 h			
	CON	XPC	FP	SEM	CON	XPC	FP	SEM
Corn/soy	3.43 ^a	4.92 ^b	7.37 ^c	0.06	4.74 ^a	6.41 ^b	9.45 ^c	0.09
Wheat/barley	2.57 ^a	3.14 ^b	4.24 ^c	0.06	5.94 ^a	6.48 ^b	8.34 ^c	0.07
Corn/soy/DDGS	2.40 ^a	2.92 ^b	6.66 ^c	0.06	4.20 ^a	4.90 ^b	8.65 ^c	0.03

^{a-c} $P < 0.05$ within substrate at each incubation time.

¹CON = control; XPC = Diamond V Original XPC; FP = Diamond V fermentation prototype; DDGS = dried distillers grain with solubles.

Key Words: *Saccharomyces cerevisiae* fermentation product, butyrate, in vitro

258 Dietary n-3 fatty acids attenuate colon endotoxin transport in growing pigs. V. Mani*¹, E. Kuntz¹, N. Boddicker¹, J. D. Spencer², and N. K. Gabler¹, ¹Iowa State University, Ames, ²JBS United Inc., Sheridan, IN.

Intestinal absorption of the bacterial endotoxin plays an important role in the development of intestinal dysfunction, inflammation, peripheral tissue catabolism and reduced pig performance by activating the immune system. However, the ability of dietary n-3 fatty acids (FA), such as docosahexaenoic acid (DHA) and eicosapentaenoic acid (EPA), to regulate intestinal endotoxin transport in growing pigs is unknown. Therefore, this study aimed to evaluate the ability of dietary n-3 FA to attenuate colon endotoxin transport and circulating endotoxin levels in growing pigs under basal or immune challenged conditions. Ten pigs (22±2.4 kg BW) were fed one of two diets, either a standard corn-soybean control diet (CON) or the CON plus 0.5% Gromega (JBS United Inc., Sheridan, IN), which was high in DHA and EPA (GRO). After 8 weeks of feeding, the CON and GRO groups were sub-divided and challenged

(n=5 pigs/trt) with an intramuscular injection of either saline (SAL) or lipopolysaccharide (CH; LPS 10 µg/kg BW). The febrile response was measured by rectal temperature hourly, blood was collected at 0 and 4 hrs for serum endotoxin levels and the pigs were euthanized 4 hrs post-challenge. Segments of the mid-colon were isolated, flushed and mounted in modified Ussing chambers to measure ex vivo FITC-LPS endotoxin transport and an apparent permeability coefficient (Papp) was calculated using the area of the membrane and transport rate. Average rectal temperatures tended to be reduced in the GRO vs CON pigs, $P < 0.055$. Furthermore, CON pigs had higher endotoxin transport compared to the GRO pigs (7.4 vs 2.0, respectively, $P = 0.02$). Irrespective of diet, CH lowered the endotoxin transport compared to the SAL pigs ($P = 0.02$). There is significant difference between CON-SAL and GRO-SAL colon Papp (11.4 vs 3.3, respectively, $P < 0.01$), however, there were no differences between the CON-CH and GRO-CH pigs. Four hour post-challenge serum endotoxin levels tended to be five-fold higher in the CON vs GRO pigs ($P = 0.07$). Overall, these data indicate that n-3 FA may mitigate colon transport and serum levels of endotoxin.

Key Words: pigs, endotoxin, intestine

259 Dietary n-3 fatty acids differentially alter ileum nutrient transport in growing pigs under immune challenge. A. Flinn*¹, V. Mani¹, M. Jeffrey¹, J. D. Spencer², and N. K. Gabler¹, ¹Iowa State University, Ames, ²JBS United Inc., Sheridan, IN.

Immune challenged pigs can have altered feed intake and reduced intestinal nutrient transport which leads to compromised growth performance and longer days to market. Therefore, we hypothesized that feeding n-3 fatty acids (FA) to growing pigs will improve ileal glucose and amino acid transport compared to control pigs. Secondly, dietary n-3 FA will attenuate reductions in nutrient transport under an immune challenge. To test this, 20 pigs (22±2.4 kg BW) were fed one of two diets from weaning to 8 weeks post weaning. Ten pigs were fed a standard corn-soybean control diet (CON) and 10 pigs were fed the CON plus 0.5% Gromega (JBS United Inc., Sheridan, IN), which was high in docosahexaenoic acid and eicosapentaenoic acid (GRO). After 8 weeks, both the CON and GRO groups were equally sub-divided (n=5/trt) and challenged with either an intramuscular injection of saline (SAL) or lipopolysaccharide (CH, 10 µg/kg BW). Following the peak febrile response, pigs were euthanized, fresh segments of the proximal ileum were collected and mounted in modified Ussing chambers to measure mucosal to serosal glucose, glutamine, threonine, lysine, a dipeptide (GlySar), and methionine transport. The change in electro-physiology were calculated and expressed relative to the CON-SAL trt. The data analysis revealed that there was no effect of diet, challenge or diet by challenge on glucose and threonine transport. Irrespective of the challenge, GRO pigs had 40% higher glutamine and lysine transport compared to the CON pigs ($P < 0.05$). Furthermore, compared to the SAL pigs, CH pigs had lower transport of glutamine, lysine and GlySar ($P < 0.05$) and a tendency for lower methionine transport ($P = 0.07$). CON-CH decreased glutamine, lysine and GlySar transport compared to the CON-SAL ($P < 0.05$). However, only glutamine and lysine transport was significantly decreased ($P < 0.05$) in the GRO-CH compared to the GRO-SAL pigs. In conclusion, these data suggest that feeding n-3 FA could selectively improve amino acid transport and immune compromised pigs may have reduced ileal nutrient transport.

Key Words: pigs, nutrient transport, intestine

Ruminant Nutrition

260 Effect of increasing level of glycerol in a feedlot diet on continuous culture fermentation characteristics. M. H. Ramos* and M. S. Kerley, *University of Missouri, Columbia.*

An experiment using single flow continuous culture fermenters was designed to measure changes in fermentation when up to 20% glycerol was added to corn-based diets. Diets consisted of four levels of glycerol (0%, 5%, 10% and 20% of DM) replacing corn. Dry matter (39.9%, 38.6%, 37.0%, 30.5%, respectively) and organic matter (45.5%, 44.4%, 44.2% and 37.2%, respectively) digestibility decreased linearly ($P < 0.05$) when glycerol levels increased in the diet; no effect was measured for CP and NDF digestibility. A linear decrease ($P < 0.05$) was also measured for pH when glycerol was increased (6.3, 6.3, 6.1 and 6.0). Total VFA production (130, 125, 131 and 132 mM) and ammonia (13, 10, 11 and 16 mg/dL) did not change ($P > 0.05$) due to glycerol level. Microbial efficiency increased (16.3, 15.1, 16.1 and 23.8, respectively) quadratically ($P < 0.05$) as glycerol levels increased, while microbial N flow was not different ($P > 0.05$) between treatments. As glycerol increased in the diet glycerol digestibility decreased (93%, 89% and 85%, respectively) linearly ($P < 0.05$). We concluded that glycerol addition to the diet did not negatively impact ruminal fermentation. Glycerol addition improved microbial efficiency at inclusion levels (5 to 10%) reported to improve feed efficiency in beef cattle.

Key Words: glycerol, feedlot, by-product

261 Effects of different levels of glycerol in feedlot diets containing steam-flaked corn. J. P. Moore*¹, J. T. Vasconcelos^{1,2}, G. E. Erickson¹, S. A. Furman², W. A. Griffin¹, and C. T. Milton³, ¹*University of Nebraska, Lincoln*, ²*University of Nebraska, Panhandle Research and Extension Center, Scottsbluff*, ³*Midwest PMS, Firestone, CO.*

A finishing study was conducted to evaluate the effects of different levels of glycerol on performance and carcass characteristics of crossbred steers ($n = 515$; initial BW = 427 kg \pm 37 kg). Steers were adapted to a finishing diet for a 21-d period, which consisted of 3 periods of 7 d in which roughage levels were decreased and corn concentration was increased. Steers were fed at 2% of the BW (DM basis) during the last 7 d of the adaptation period. After adaptation, cattle were weighed (d 0) and blocked by BW (10 blocks). Cattle were then assigned randomly to 40 pens (12 - 13 steers/pen), and 4 dietary treatments were assigned randomly to pens (10 pens/treatment). Treatments included increasing levels (0, 3, 6 and 9%) of glycerol replacing steam-flaked corn. Final BW increased ($P = 0.05$) linearly with increasing levels of glycerol. There was a quadratic ($P = 0.03$) response in DMI with the greatest DMI at 6% inclusion (10.9 kg/d). Average daily gain increased ($P = 0.02$) linearly from 1.41 kg/d (0% inclusion) to 1.48 kg/d (9% inclusion). G:F improved linearly ($P < 0.01$) with increasing glycerol inclusion. HCW increased ($P = 0.05$) linearly with increasing glycerol inclusion with the heaviest carcass for 6% inclusion (386 kg). There tended to be a linear ($P = 0.08$) increase in LM area with increased glycerol inclusion. No differences in glycerol inclusion levels were observed for 12th rib fat ($P \geq 0.76$), yield grade ($P \geq 0.56$), marbling score ($P \geq 0.20$), or occurrence of liver abscesses ($P = 0.28$). Improved performance was observed by feeding up to a 9% glycerol inclusion, by decreasing DMI 3%, increasing ADG 5%, and G:F by 8%. There were no effects on carcass characteristics when glycerol was included in the diet. These data suggest that glycerol could be added to steam-flaked corn-based feedlot diets.

Key Words: feedlot cattle, glycerol, steam-flaked corn

262 Effects of low levels of crude glycerin with or without coproducts on performance and carcass characteristics of feedlot heifers. C. J. Schneider*, G. L. Parsons, K. A. Miller, L. K. Thompson, and J. S. Drouillard, *Kansas State University, Manhattan.*

A trial was conducted to evaluate finishing performance and carcass traits of heifers ($n = 295$; 427 kg BW; SEM 8.8 kg) fed low levels of glycerol (0, 0.5, or 2% of diet DM) in flaked corn finishing diets, or diets that combined flaked corn with soybean hulls and wet distillers grains (0 or 2% glycerol). Diets contained steam-flaked corn with 3% alfalfa hay and 6% corn silage, and provided 300 mg monensin, 90 mg tylosin, and 0.5 mg melengestrol acetate per heifer daily. In the byproduct diets, 25% soybean hulls and 15% wet distillers grains (DM basis) replaced steam-flaked corn. Cattle were stratified by body weight and randomly assigned (within strata) to 40 concrete-surfaced pens containing 7 to 8 cattle per pen, with 8 pens per treatment. Cattle had ad libitum access to feed and water and were fed once daily for 89 d. Increasing glycerol levels in the diet decreased DMI (Lin, $P = 0.04$). Feeding byproducts increased DMI when compared to diets without byproducts ($P < 0.01$). ADG was not affected by diet ($P > 0.30$); 1.34, 1.22, 1.16 kg/d for cattle fed 0, 0.5, and 2% glycerol without byproducts, respectively, and 1.30 and 1.19 kg/d for heifers fed diets with byproducts diets containing 0 or 2% glycerol. Carcass adjusted G ÷ F was poorer when byproducts were fed ($P < 0.01$), but was unaffected by glycerol concentration ($P > 0.2$). In addition, adding glycerol to diets without byproducts decreased the percentage of carcasses that graded USDA Choice or higher (Lin; $P = 0.03$), and increased the percentage of carcasses that graded USDA Select (Lin; $P = 0.02$). Similarly, addition of byproducts decreased the percentage of carcasses that graded USDA Choice or higher and increased the percentage of carcasses that graded USDA Select ($P < 0.05$). No other performance or carcass characteristics were affected by the addition of byproducts or glycerol to the diet. In contrast to previous studies, feeding low levels of glycerol failed to yield improvements in feedlot performance.

Key Words: glycerol, steam-flaked corn, wet distillers grains

263 Method for lipid and NDF analysis of ethanol byproduct feedstuffs. V. R. Bremer*, C. D. Buckner, A. W. Brown, T. P. Carr, R. M. Diedrichsen, G. E. Erickson, and T. J. Klopfenstein, *University of Nebraska, Lincoln.*

Four experiments were conducted to evaluate the performance of a new biphasic lipid and NDF analytical procedure for byproduct feeds. Exp. 1 and 2 were conducted to optimize the hours of sample incubation in solvent and solvent ratio of diethyl ether to hexanes for a biphasic byproduct lipid analytical procedure. Exp. 3 compared condensed corn distillers soluble (CCDS) lipid extraction with a 5 hr Goldfish diethyl ether procedure to the appropriate procedure from Exp. 1 and 2. Exp. 4 evaluated the NDF content of corn dried distillers grains (DDG) with differing levels of CCDS addition with and without pre-NDF lipid extraction. Exp. 1 and 2 indicated that a 10 hr incubation of samples with a 1 ÷ 1 ratio of diethyl ether to hexanes was appropriate for the biphasic lipid extraction procedure. Increased solvent proportion of diethyl ether extracted non-lipid material from byproduct samples ($P < 0.01$). Exp. 3 indicated the ratio of GLC analyzed fatty acids quantity to mass of lipid extract was lower for the Goldfish procedure ($P = 0.01$) than for the biphasic extraction, indicating that non-lipid material was

being extracted with the Goldfisch procedure. The Goldfisch procedure CCDS non-fatty acid extract ranged from 3 to 10% of sample DM. Exp. 4 indicated decreased DDG NDF values with pre-NDF fat extraction compared to no pre-NDF extraction ($P < 0.01$). Values were 33.9 and 35.6% NDF, respectively. This indicates fat interferes with NDF determination of byproduct feeds. These data collectively indicate that a 10 hr incubation of samples with a 1 ÷ 1 diethyl ether ÷ hexanes solvent for biphasic extraction of feedstuff lipids has increased accuracy relative to Goldfisch diethyl ether extraction, especially for CCDS. A pre-NDF fat extraction must be completed prior to analyzing high fat feeds (>7% of sample DM) for NDF. Combining the biphasic fat procedure with NDF analysis provides an effective way to analyze both nutrients in high-fat byproduct feeds.

Key Words: byproducts, lipid, NDF

264 Effects of levels of roughage and corn wet distillers grains with solubles in steam-flaked corn-based substrates on IVDMD, hydrogen sulfide production, and in vitro gas production kinetics. M. L. May*, M. J. Quinn, N. DiLorenzo, and M. L. Galyean, *Texas Tech University, Lubbock*.

In vitro experiments were conducted to evaluate levels of corn distillers grain (CDG) and alfalfa hay (AH) in high-concentrate substrates on IVDMD and gas production. Seven treatments consisted of a control substrate containing (DM basis) 0% CDG and 10% AH, and 15 or 30% (DM basis) CDG, each with 7.5, 10, or 12.5% AH. Two ruminally cannulated Jersey steers were adapted to a 60% concentrate diet, and ruminal fluid was collected 4 h after feeding to use as inoculum. Cultures inoculated with McDougall's buffer and ruminal fluid (3:1) were used to evaluate gas production kinetics in a wireless gas pressure monitoring system and H₂S production in sealed serum vials. Incubations (24 h) were conducted in triplicate on 2 separate days (blocks), with data analyzed as a randomized complete block design with a 3 (AH) × 2 (CDG) + 1 (control) factorial arrangement. Increasing CDG from 15 to 30% increased maximal gas production; however, an AH level × CDG level interaction ($P < 0.01$) was detected, with values increasing as AH level increased in the 15% CDG substrates but decreasing as AH level increased in the 30% CDG substrates. Similarly, there was a tendency ($P = 0.06$) for a linear AH level × CDG level interaction for rate of gas production, with rate being greater in the 15% CDG substrates as AH level increased but with little change across AH levels for 30% CDG. Gas production per gram of fermentable DM tended ($P < 0.09$) to respond quadratically to the AH level × CDG level interaction. Increasing CDG from 15 to 30% increased H₂S production ($P < 0.05$), with a tendency ($P = 0.07$) to decrease IVDMD. Relative to the control substrate, including CDG increased H₂S production, maximal gas production, and area under the gas production curve ($P < 0.05$). Treatments did not affect lag time ($P > 0.16$) for gas production. Results indicate that increasing CDG concentration increased in vitro H₂S production with a tendency to decrease IVDMD, and including CDG increased maximal gas production and area under the gas production curve.

Key Words: distillers grains, IVDMD, hydrogen sulfide

265 Effects of distillers grains and substrate steam-flaked corn concentration on IVDMD, gas production kinetics, and hydrogen sulfide production. M. J. Quinn*, M. L. May, N. DiLorenzo, D. R. Smith, and M. L. Galyean, *Texas Tech University, Lubbock*.

Effects of 3 levels of distillers grains (DG) and 3 ratios of steam-flaked corn (SFC) to ground whole corn (WC) were used to evaluate IVDMD, in vitro gas production kinetics, and in vitro H₂S production. Two ruminally cannulated Jersey-crossbred steers fed 60% concentrate diets based on SFC were used as ruminal fluid donors. Cultures inoculated with ruminal fluid were used to evaluate gas production kinetics using Ankom wireless monitoring systems attached to 250 mL flasks and H₂S production was evaluated in batch cultures with sealed 150 mL serum vials incubated for 24 h. Substrates included corn (CDG) or sorghum distillers grains (SDG) and were evaluated in 2 separate experiments. Within each type of DG, treatments were 0, 15, or 30% (DM basis) DG and ratios of SFC:WC of 50:50, 75:25, or 100:0. Replicate incubations for each treatment were repeated on separate days. When CDG was the DG source, a tendency ($P = 0.06$) was noted for a linear increase in IVDMD as the percentage of SFC increased in substrates, and increasing CDG level increased H₂S production linearly ($P < 0.01$). Two interactions were observed with CDG: a linear SFC × quadratic DG level for total gas produced in a 24-h, sealed vial incubation ($P = 0.05$); and a quadratic SFC × quadratic DG level interaction for maximal gas production ($P < 0.01$) estimated from gas production measured over time. A quadratic decrease ($P = 0.04$) was noted for rate of gas production and area under the gas production curve as CDG increased in substrates. With SDG, IVDMD increased as the percentage of SFC increased ($P = 0.02$) and tended ($P = 0.09$) to increase with increasing DG level. Similar to CDG, H₂S production increased linearly with increasing concentrations of SDG ($P = 0.02$). Linear SFC × quadratic DG level contrast interactions were noted for both rate of gas production (k) and maximal gas production ($P < 0.03$). Overall, increasing concentration of CDG or SDG increased in vitro H₂S production, whereas increasing the percentage of SFC in substrates generally increased IVDMD with only moderate effects on gas production kinetics.

Key Words: distillers grains, IVDMD, grain processing

266 Effect of dehydrated yeast culture on in vitro gas and hydrogen sulfide production in cultures using low- or high-sulfur feedlot diets as substrate. J. M. Kelzer*¹, M. V. Fossa¹, M. Ruiz-Moreno¹, G. I. Crawford², and A. DiCostanzo¹, ¹University of Minnesota, St. Paul, ²University of Minnesota Extension Regional Office, Hutchinson.

Effect of including dehydrated yeast culture in low- and high-sulfur (S) feedlot diets on 24-h in vitro fermentation and hydrogen sulfide (H₂S) production were evaluated. Ruminal fluid collected separately from two dairy cows fed a 60:40 forage:concentrate ration was used to inoculate the cultures. One cow was adapted to 56 g/d YC for 21-d prior to ruminal fluid collection. Treatments were arranged in a 2 × 2 × 2 factorial, with two levels of dietary S (0.25% DM, LS or 0.50% DM, HS), YC inclusion (0% YC, NoYC or 1.03% YC, YC), and ruminal fluid source (0 d YC adaptation, NoADAPT or 21 d YC adaptation, ADAPT). Approximately 0.71 g DM of substrate and 50 mL of 1:1 ruminal fluid to McDougall's saliva were incubated in crimp-sealed, 125 mL serum bottles (2 periods; n = 32 bottles per period; 8 replicates/treatment total) for 24 h at 39°C. At 24 h, total gas production and pH were measured, and 5 mL gas were extracted for H₂S analysis. Corrected

24-h gas production was used to determine total H₂S production. Rates of gas and H₂S production were determined by dividing total gas (mL) and H₂S (µg) by incubation time (1440 min). Total gas production was reduced ($P = 0.0003$) with NoADAPT (142.1 vs. 148.6 ± 1.3 mL) in HS diets but was similar (151.7 vs. 152.2 mL) in LS diets. Rate of gas production was lower ($P = 0.0003$) with NoADAPT (0.099 vs. 0.103 ± 0.001 mL/min) in HS diets but was similar (0.105 vs. 0.106 mL/min) in LS diets. Inclusion of YC increased ($P = 0.0005$) H₂S (2.76 vs. 2.58 ± 0.14 µg/mL gas) in HS diets but did not affect H₂S (1.12 vs. 1.14 µg/mL gas) in LS diets. Rate of H₂S production was greater ($P = 0.0001$) with YC (0.283 vs. 0.255 ± 0.013 µg/min) in HS diets but was similar (0.120 vs. 0.119 µg/min) in LS diets. Main effects for final pH were higher ($P < 0.0001$) for HS (5.88 vs. 5.81), NoYC (5.88 vs. 5.82), and ADAPT (5.89 vs. 5.80). In an in vitro ruminal fluid culture system, YC appears to increase microbial fermentation, reduce pH, and increase H₂S production in high S diets; however, this H₂S response warrants confirmation using IVDMD or VFA production.

Key Words: yeast culture, hydrogen sulfide, in vitro fermentation

267 Effect of manganese oxide on in vitro gas and hydrogen sulfide production in cultures using high-sulfur distillers grains-based substrate. J. M. Kelzer^{*1}, M. Ruiz-Moreno¹, A. DiCostanzo¹, and G. I. Crawford², ¹University of Minnesota, St. Paul, ²University of Minnesota Extension Regional Office, Hutchinson.

Effect of six concentrations (DM-basis; 0 [control], 500, 1000, 1500, 2000, 2500 ppm) of manganese (Mn; supplied as MnO) on in vitro gas and hydrogen sulfide (H₂S) production were evaluated. Rumen fluid collected from a dairy cow fed a 60:40 forage:concentrate ration was used to inoculate the culture. Manganese oxide was hand-mixed into substrate (81% distillers grains, 19% ground corn, 0.65% S) to obtain treatment concentrations of Mn. Approximately 0.7 g DM of substrate and 50 mL of 1:1 rumen fluid to McDougall's saliva were incubated in crimp-sealed, 125 mL serum bottles ($n = 24$; 4 reps/concentration) for 24 h at 39 °C. At 2, 5, 10, and 24-h post-inoculation, bottles were briefly removed for gas measurement, and 5 mL gas was extracted for H₂S analysis. At 2 h, gas produced and total H₂S released were similar ($P > 0.10$) across Mn concentrations and averaged 83.2 ± 1.5 mL and 23.1 ± 8.1 µg, respectively. At 24-h, incubation with 2000 ppm Mn produced more ($P = 0.03$) gas than control and 500 ppm Mn (216.8 vs. 212.4 and 212.3 mL, respectively) and less ($P < 0.02$) H₂S than control, 500, 1500, and 2500 ppm Mn (198.1 vs. 238.7, 249.1, 226.9, and 245.2 µg, respectively), but 2000 ppm Mn released similar ($P = 0.42$) H₂S as 1000 ppm Mn (206.8 µg). Total H₂S per mL gas produced tended ($P = 0.09$) to be lower with 1000 and 2000 ppm Mn compared to control, 500, 1500, and 2500 ppm Mn (0.97 and 0.91 vs. 1.12, 1.18, 1.07, and 1.17 ± 0.07 µg/mL, respectively). Final pH tended ($P = 0.06$) to be lower for control than 500, 1000, and 1500 ppm Mn (5.70 vs. 5.74, 5.73, and 5.74 ± 0.07) but was similar to 2000 (5.72) and 2500 (5.71) ppm Mn. Concentrations between 1000 and 2000 ppm Mn supplied as MnO demonstrated potential to decrease 24-h H₂S production from high-sulfur substrate without reducing microbial fermentation in an in vitro ruminal fluid culture system.

Key Words: manganese oxide, hydrogen sulfide, in vitro fermentation

268 Effects of limit feeding corn or dried distillers grains (DDGS) at two intakes during the growing phase on feedlot cattle performance. T. L. Felix^{*} and S. C. Loerch, *The Ohio State University, Wooster.*

Energy density in growing diets affects carcass quality of cattle; however, few reports have described impacts of energy source. The objectives of this research were to determine effects of source (DDGS vs. corn) and amount (limit-fed to gain 0.9 vs. 1.4 kg/d) of energy during the growing phase on feedlot performance and marbling. Angus-cross steers (144 hd) were blocked by weight (avg BW = 252 ± 1.0 kg) and allotted within each block to 8 pens (6 steers/pen, 24 pens total), and randomly assigned to 1 of 4 feeding systems: 1) 65% DDGS fed to gain 0.9 kg/d, 2) 65% DDGS fed to gain 1.4 kg/d, 3) 65% corn fed to gain 0.9 kg/d, and 4) 65% corn fed to gain 1.4 kg/d. After the 98 d growing phase, all steers were fed the same finishing diet containing 25% DDGS. Steers in a pen were slaughtered when the pen weight reached the terminal target weight of 544, 522, and 499 kg for the large, medium, and small blocks, respectively. Average daily gain and DMI differed ($P < 0.001$) by design during the growing phase; ADG for the 4 feeding systems listed above was 0.89, 1.26, 1.24, and 1.68 kg/d, respectively. The ADG was greatest ($P = 0.02$) during the finishing phase in steers fed to gain 0.9 kg/d initially; ADG was 1.97, 1.74, 1.88, and 1.63 kg/d, respectively for the 4 systems. Steers fed to gain 0.9 kg/d during the growing phase also had less back fat ($P = 0.08$) and greater ribeye area ($P = 0.003$) than steers fed to gain 1.4 kg/d. This led to lower yield grades ($P = 0.026$) from steers gaining 0.9 kg/d during the growing phase, likely because these steers synthesized more protein and less fat. There was an interaction with energy source and amount for marbling scores ($P = 0.016$). Steers fed to gain 0.9 kg/d on corn during the growing phase had the highest marbling (590) while those fed to gain 0.9 kg/d on DDGS had the lowest marbling (533); the remaining feeding systems were intermediate. Overall ADG and DMI was affected ($P < 0.06$) by source and amount of energy during the growing phase. Increasing intakes of DDGS during the growing phase increased marbling while increasing intakes of corn decreased marbling.

Key Words: distillers grains, growing cattle, limit feeding

269 Ensiled or fresh mixed wet distillers grains with solubles and straw in growing diets. C. D. Buckner^{*1}, W. A. Griffin¹, J. R. Benton¹, T. J. Klopfenstein¹, G. E. Erickson¹, and M. E. Corrigan², ¹University of Nebraska, Lincoln, ²Lallemand Animal Nutrition North American, Milwaukee, WI.

An 84 d growing trial was conducted to evaluate wet distillers grains with solubles (WDGS) and straw fed fresh or ensiled on steer performance. Treatments were designed as a 2 × 3 factorial with level (30 or 45% WDGS with the remainder as straw) and storage type (fresh, or ensiled with, or without an inoculum). The inoculum provided 500,000 colony forming units of *Lactobacillus buchneri* per gram of as-is mixture. Steers in the fresh group were fed ad libitum and steers fed the ensiled mixture were pair-fed to steers in the fresh group of equal BW to evaluate energy value and ensure equal DMI. No interactions ($P \geq 0.10$) were observed between level and storage type. Feeding 45% WDGS resulted in greater final BW, ADG, DMI, and G:F ($P \leq 0.05$) compared to 30% WDGS. Greater ADG and G:F ($P \leq 0.02$) resulted from feeding the ensiled mixes compared to the fresh mixes. Feeding these mixtures ensiled suggested improved palatability and digestibility as a result of increased cattle performance with little change due to the inoculum.

Table 1.

Item	WDGS Level			Storage Type				Inter
	30	45	P-value	Fresh	Ens. no Inoc	Ens. w Inoc	P-value	
DMI, kg/d	4.2	4.4	0.05	4.3	4.3	4.3	0.99	1.0
ADG, kg	0.37	0.55	<0.01	0.40 ^a	0.49 ^b	0.50 ^b	0.02	0.16
G:F	0.088	0.125	<0.01	0.093 ^a	0.111 ^b	0.116 ^b	<0.01	0.10

^{a,b}Means within storage type and the same row without a common superscript differ ($P \leq 0.05$).

Key Words: wet distillers grains with solubles, growing cattle, storage

270 Effects of feeding high distillers grains and wheat straw on nutrient mass balance and performance of feedlot steers. A. R. Rich*, G. E. Erickson, T. J. Klopfenstein, M. K. Luebbe, J. R. Benton, and W. A. Griffin, *University of Nebraska, Lincoln*.

A winter experiment was conducted to compare feeding a high inclusion of wet distillers grains plus solubles (WDGS) with wheat straw to corn on steer performance, manure N, and N loss. Crossbred steer calves (311 ± 10kg) were stratified by BW, and assigned randomly to 16 pens (8 steers/pen) and fed for 173 d from November to May. Four treatments were tested as a 2 × 2 factorial with factors being diet and pen cleaning frequency (monthly or at the end of the feeding period). Diets consisted of 85% corn, 5% molasses, and 5% wheat straw (CON) or 70% WDGS and 25% wheat straw (BYP). Both diets contained 5% supplement. Nitrogen excretion was determined by difference between N intake and N retention. Total N lost was calculated by subtracting manure and runoff N from excreted N. No runoff was collected during the 173 d experiment. There was not an interaction between diet and cleaning frequency ($P > 0.37$) for any variables so only the main effects are presented. Steers fed CON had greater DMI, ADG, HCW, marbling, and fat depth ($P < 0.01$) compared to BYP. Due to decreased ADG, steers fed BYP were fed an additional 56 d for performance, but mass balance data are for 173 d only. Cleaning frequency had no impact ($P > 0.4$) on performance. There was a greater amount ($P < 0.01$) of N intake and N excretion for the steers fed BYP compared to CON ($P < 0.01$) due to differences in CP between diets. However, manure N was not different ($P = 0.63$) between BYP and CON. Amount ($P < 0.01$) and percentage ($P = 0.08$) of N lost was greater for BYP compared to CON due to greater N intake. Cleaning pens monthly numerically ($P = 0.21$) decreased amount of N lost by 3.4 kg compared to cleaning once at the end. Cleaning monthly compared to once at the end did not increase manure N ($P = 0.24$) despite increasing ($P = 0.05$) manure OM removed from pens. Feeding 70% WDGS with 25% wheat straw decreases ADG and G:F as well as increases N intake and losses from feedlots.

Key Words: mass balance, nitrogen, wet distillers grains plus solubles

271 Feeding increased amounts of wet distillers grains plus solubles on feedlot cattle performance. A. R. Rich*, G. E. Erickson, T. J. Klopfenstein, M. K. Luebbe, J. R. Benton, and W. A. Griffin, *University of Nebraska, Lincoln*.

A finishing study evaluated inclusion of corn wet distillers grains plus solubles (WDGS) and wheat straw on the performance and carcass characteristics of 336 (270 ± 9kg) crossbred steers. Seven treatments included: 1) control (CON) containing 85% corn and 4.7% wheat straw, 2) 40% WDGS and 4.7% wheat straw (40–5), 3) 70% WDGS and 8.23% wheat straw (70–8), 4) 77.5% WDGS and 9.1% wheat straw (77–9), 5) 85% WDGS and 10% wheat straw (85–10), 6) 77.5% and 17.5% wheat straw (77–17), 7) 70% WDGS and 25% wheat straw (70–25). Six pens per treatment (8 steers/pen) were used in the RCBD experiment. The CON, 40–25, 70–8, and 77–9 were fed for 183 d and the 70–25, 77–17, and 85–10 treatments were fed 225 d to target similar final BW. Steers fed the 40–5 had the greatest ($P < 0.01$) ADG, G:F, and HCW; however, G:F was similar to 77–9. Steers fed 70–25 had the least ($P < 0.01$) ADG, G:F, and HCW. Steers being fed the CON, 70–8, and 77–9 had similar ADG, followed by steers fed 77–17, then 85–10, which were different ($P < 0.01$). Steers fed CON, 85–10, and 77–17 had similar G:F ($P > 0.10$) but less ($P < 0.05$) than 40–5, 70–8, and 77–9. However, steers fed 85–10, 77–17, and 70–25 were fed 42 d longer. Marbling score was greatest ($P < 0.05$) for CON and 40–5, least ($P < 0.05$) for 70–25, and intermediate for the other treatments. Feeding WDGS at 40% inclusion improved ADG and G:F. Feeding 70 to 77% WDGS resulted in similar ADG and improved G:F compared to corn. Increasing straw above 10% or WDGS above 77% depressed ADG, G:F, or both compared to corn.

Table 1.

Item	CON	40–5	70–8	77–9	85–10	77–17	70–25	SEM
DOF	183	183	183	183	225	225	225	
ADG, kg/d	1.64 ^b	1.97 ^a	1.66 ^b	1.61 ^b	1.31 ^d	1.40 ^c	1.13 ^c	0.06
G:F	0.160 ^c	0.189 ^a	0.181 ^b	0.187 ^{ab}	0.162 ^c	0.157 ^{c1}	0.138 ^d	0.002
HCW, kg	359 ^b	398 ^a	361 ^b	357 ^b	356 ^b	367 ^c	330 ^b	10

^{a-c}Within a row, means without common superscript differ ($P \leq 0.05$)

Key Words: feedlot cattle, roughage, wet distillers grains plus solubles

272 Meta analysis of feeding winter calf-feds or summer yearlings wet distillers grains with different corn processing types. V. R. Bremer*, K. J. Hanford, G. E. Erickson, and T. J. Klopfenstein, *University of Nebraska, Lincoln*.

A meta analysis of UNL feedlot research trials (16 trials, 258 pen means, 2,534 steers) where corn wet distillers grains (WDGS) was fed with either dry rolled corn (DRC) or a blend of DRC and high moisture corn (BLEND) to either winter calf-feds or summer yearlings was conducted to evaluate differences in steer performance due to WDGS inclusion level with DRC or BLEND with either winter calf-feds or summer yearlings. Pen mean was the experimental unit. The model indicated improved cattle performance and improved feeding value of WDGS relative to corn as previously reported (148, 141, 134, 128, and 121% feeding value of corn for 10, 20, 30, 40, and 50% of diet DM as WDGS, respectively). New findings indicate the feeding value of WDGS was greater with summer yearlings than winter calf-

feeds regardless of corn processing type (146 vs. 134 for DRC and 129 vs. 123 for BLEND at 40% WDGS, respectively). The WDGS response when feeding BLEND was slightly less than the response when feeding DRC. In addition, one trial compared high quality high moisture corn (HMC; 30% moisture) vs. DRC in WDGS diets. There was a 14% improvement in feeding value due to feeding HMC in place of DRC without WDGS. The feeding value of 40% WDGS in the HMC diet was 115% of the HMC displaced. The combination of the HMC with WDGS (87.5% of diet DM total) had a feeding value of 122% of the DRC replaced. The HMC with WDGS data indicated a lesser response to WDGS in the HMC diet than the DRC or BLEND diets in the meta analysis. However, the overall response to WDGS and HMC was superior to DRC alone. The response to WDGS in BLEND and HMC diets was slightly less than the response with DRC. These data indicate differences in steer performance when fed WDGS due to WDGS inclusion level, season of cattle feeding or cattle type and corn processing method.

Key Words: byproducts, corn processing, WDGS

273 Metabolism by steers consuming wet corn gluten feed or wet distillers grains with solubles based finishing diets. C. D. Buckner*, K. M. Rolfe, N. F. Meyer, T. J. Klopfenstein, and G. E. Erickson, *University of Nebraska, Lincoln*.

A 6 × 6 unbalanced Latin square designed metabolism trial was conducted to evaluate wet corn gluten feed (WCGF) and wet distillers grains with solubles (WDGS) on nutrient digestibility, ruminal pH and volatile fatty acids using 7 steers. Treatments were designed as a 3 × 2 factorial with three diets containing 35% WCGF, 88% WCGF, or 35% WDGS and direct fed microbial levels (DFM) of 0 or 1 × 10⁹ CFU's of *Lactobacillus buchneri*. Diets contained 7.5% alfalfa hay, 5% supplement, and the remainder as dry rolled corn. No interactions ($P \geq 0.97$) were observed for DM or NDF intake. The greatest DM and NDF intakes were observed by feeding 35% WCGF and 88% WCGF, respectively. Feeding the DFM resulted in greater DMI ($P = 0.04$) and NDF intake ($P = 0.10$). An interaction ($P = 0.08$) resulted for DM digestibility and a tendency ($P = 0.15$) for NDF digestibility. Regardless of DFM, digestibility of DM was greater for steers fed 35% WCGF (79.2%) or WDGS (78.5%) compared to 88% WCGF (74.9%), but the DFM increased ($P = 0.06$) DM digestibility for steers fed the 88% WCGF diet. Feeding steers 88% WCGF resulted in greater NDF digestibility (70.7%) compared to 35% WCGF (66.9%) and 35% WDGS (66.5%), with the highest numeric value observed for feeding 88% WCGF with the DFM (72.3%). No interactions ($P \geq 0.42$) resulted for any ruminal pH measures. Feeding 88% WCGF resulted in the highest pH values (6.07) and 35% WCGF resulted in the lowest values (5.13; $P < 0.05$). Diet affected time and area below pH 5.6 ($P < 0.01$) with the lowest values observed for steers fed 88% WCGF and the highest values for steers fed 35% WCGF. No pH differences ($P > 0.10$) were observed by feeding DFM except for minimum pH, which was lower for steers given the DFM. Molar proportions of propionate were decreased when feeding 88% WCGF compared to the other two diets. Feeding WCGF in finishing diets can increase DM and NDF intakes compared to WDGS and including this at a high level increases NDF digestibility and ruminal pH.

Key Words: corn gluten feed, distillers grains, beef cattle

274 (Invited ASAS Animal Science Young Scholar) Plasma leptin and ghrelin concentrations and abundance of the growth hormone secretagogue receptor in beef cattle exhibiting differences in composition of gain. J. S. Jennings*, R. H. Pritchard¹, D. H. Keisler², A. D. Weaver¹, J. A. Clapper¹, and A. E. Wertz-Lutz¹, ¹South Dakota State University, Brookings, ²University of Missouri, Columbia.

Beef steers (n=72) of similar age, weight (292 ± 1.4 kg), and genetic background (Angus crossbred) were used to determine the effects of composition of gain on plasma ghrelin and leptin, and growth hormone secretagogue receptor (GHS-R) abundance. At trial initiation, 8 steers were harvested for initial carcass composition. The remaining 64 steers were allotted, by weight, to pen and treatment was assigned randomly. To achieve differences in rate and composition of gain, the following treatments were used: 1) ad libitum high-forage diet fed during the growing period (0-116 d) followed by a high-concentrate during the finishing period (117-209 d; GRW-FNSH) or 2) ad libitum high-concentrate fed for the duration of the trial (0-209 d; FNSH-FNSH). Eight steers per treatment were harvested on d 88, 116, 165, and 209; and 9-10-11 rib sections were removed for compositional analyses. Blood samples collected before each harvest were assayed for plasma ghrelin, leptin, GH, insulin, and NEFA. At harvest, liver, muscle and adipose tissues were collected. Proteins were separated using SDS-PAGE, and GHS-R abundance was determined using Western blotting. Hormones, growth, carcass composition, and protein abundance were analyzed using the GLM procedure of SAS. Differences that resulted from treatment, harvest date, or their interaction were separated using least squares means. Leptin:ghrelin was greater ($P \leq 0.01$) for FNSH-FNSH steers during the growing period, whereas leptin:ghrelin was increased for GRW-FNSH steers during realimentation. At each harvest day, FNSH-FNSH steers had greater carcass fat ($P \leq 0.01$) compared with GRW-FNSH steers. Percentage of the carcass composed of protein was greater in the GRW-FNSH steers ($P \leq 0.01$) compared with FNSH-FNSH. A treatment by harvest day interaction ($P \leq 0.05$) resulted for abundance of GHS-R in liver and subcutaneous adipose tissue, however GHS-R was not detected in the muscle tissue.

Key Words: ghrelin, leptin, GHS-R

275 The value of feeding lactic acid cultures (Bovamine) on digestive tract morphology of neo-natal/transition Holstein bull calves and performance and carcass characteristics of long-fed Holstein steers. K. J. Dick¹, G. C. Duff*¹, S. W. Limesand¹, S. P. Cuneo¹, D. K. Knudson¹, C. P. McMurphy¹, L. W. Hall¹, J. C. Bernal-Rigoli¹, J. A. Marchello¹, and W. Kreikemeier², ¹University of Arizona, Tucson, ²Nutrition Physiology Company, LLC, Guymon, OK.

Two experiments were conducted to evaluate the effects of live cultures of *Lactobacillus acidophilus* and *Propionibacterium freudenreichii* on digestive tract morphology of neo-natal/transition Holstein bull calves and performance and carcass characteristics of long-fed Holstein steers. In Exp. 1, 43, one-day old Holstein bull calves (42 kg BW) were supplemented with a direct-fed microbial (DFM) consisting of *L. acidophilus* and *P. freudenreichii*. Treatments consisted of a control (n = 21) and a treatment (n=22) of DFM (5 × 10⁸ cfu) supplemented daily in a commercial milk replacer. At weaning, 11 calves from each treatment group were euthanized for digestive tract (GIT) collection. The remaining calves were abruptly weaned for 14 d before euthanized (DFM treatments were mixed in the diet). Before weaning, avg ileal height, crypt depth, and total height (villus + crypt) were greater in

DFM treatments ($P < 0.03$) compared with controls. After weaning, avg ruminal papillae width and density was greater in calves receiving DFM vs. controls. In Exp. 2, calves were fed control (no DFM) or 1×10^5 or 1×10^6 *L. acidophilus* strain NP 51 plus 1×10^9 *P. freudenreichii* strain NP24 from d 0 through finishing. During the pre-weaning phase, Holstein calves supplemented with DFM had greater ($P < 0.07$) ADG vs. controls with a tendency ($P < 0.11$) for a quadratic response with calves receiving 1×10^5 having the greatest ADG. Likewise, calves receiving 1×10^5 *L. acidophilus* had the greatest ADG (0 vs NP51, $P < 0.07$; quadratic, $P < 0.07$). No statistical differences were noted for feed intake or efficiency or carcass characteristics during Exp. 2. Supplementing long-fed Holstein steers with 1×10^5 *L. acidophilus* strain NP 51 plus 1×10^9 *P. freudenreichii* strain NP24 from birth through finishing increases ADG. These data also suggest that direct-fed microbials may increase performance by increasing the nutrient absorptive surface area in the rumen and ileum, resulting in a healthier digestive tract.

Key Words: Holstein steers, Bovamine, performance

276 Bovine intestinal mucus as a substrate for growth of *E. coli* O157:H7. C. Aperce*, J. Heidenreich, and J. Drouillard, *Kansas State University, Animal Sciences and Industry, Manhattan.*

The objective of this study was to evaluate the capacity of bovine intestinal mucus and its constituents to support growth of *E. coli* O157:H7, and to evaluate the role of various enzymes and enzyme inhibitors in this growth process. Intestinal tissues were obtained from freshly slaughtered cattle and transported to our laboratory in chilled saline. Sections of the ileum and colon were washed with buffer solution and mucus was harvested by gently scraping the epithelium. Harvested intestinal mucus or its components (galactose, D-galacturonic acid, D-gluconic acid, D-glucuronic acid, mannose, L-alpha-phosphatidylserine, N-acetyl-D-glucosamine and sialic acid) were added to buffer solutions with or without fecal inoculum collected from a steer fed a high-concentrate diet. Culture tubes were inoculated with 10^3 CFU/mL of a 5-strain mixture of nalidixic acid-resistant (Nal^r) *E. coli* O157:H7. Cultures were incubated anaerobically at 40°C on a laboratory shaker for 0, 6, 8 or 12 h. In response to increasing concentration of mucus, Nal^r *E. coli* O157:H7 growth increased linearly ($P < 0.01$), but total anaerobic plate counts were unchanged ($P > 0.05$). Growth of Nal^r *E. coli* O157:H7 was greater with whole intestinal mucus compared to individual constituents of mucus, the exception being sialic acid, which yielded growth equal ($P > 0.50$) to that of whole mucus. The incorporations of protease, lipase, endoglycosidase, or sialidase had no effects on the growth of *E. coli* O157:H7 ($P > 0.05$). Conversely, the addition of the beta-galactosidase inhibitor, phenylethyl beta-D-thiogalactopyranoside, resulted in substantial increases in growth of *E. coli* O157:H7. Our results indicated that *E. coli* O157:H7 can utilize mucus and its components as substrates to support its growth. Further investigations are needed to evaluate if enzymes and inhibitors of enzymes can influence colonization of the bovine gastrointestinal tract by important food-borne pathogens.

Key Words: *E. coli* O157:H7, intestinal mucus

277 Effect of health treatments on feedlot performance, carcass traits and profitability of beef calves fed in the Iowa Tri-County Steer Carcass Futurity. G. D. Fike^{*1}, L. R. Corah¹, M. E. King¹, and W. D. Busby², ¹*Certified Angus Beef LLC, Wooster, OH*, ²*Iowa State University, Ames.*

Beef calves (n = 47, 764) fed at 18 Iowa feedlots through the Iowa Tri-County Steer Carcass Futurity over eight years (2002-09) were used to evaluate the effect of the number of health treatments on feedlot performance, carcass traits and profitability. A common diet was fed and similar implant and health programs were administered to all calves. Calves were sorted and harvested when visually determined to have one cm of fat cover. Calves were divided into three groups based on the number of times the animal was treated for disease conditions: non-treated calves (NT), calves that were treated once (1T) and calves that were treated two or more times (2T). Unless otherwise stated, each of the three means for each outcome was different from all other means ($P < 0.05$). The mean delivery weights, final weights and hot carcass weights were 295, 280 and 273.8 kg; 536.8, 524.3 and 514.3 kg; and 330.6, 322.7 and 317.7 kg for NT, 1T and 2T calves, respectively. As the number of treatments increased, days on feed increased (167, 177.9 and 183.7 d), ADG decreased (1.46, 1.39 and 1.33 kg/d), F:G improved (6.89, 6.76 and 6.66 kg/kg) and cost of gain increased (1.36, 1.52 and 1.64 USD/kg). Calves with fewer treatments had more rib fat (1.14, 1.09 and 1.00 cm) and greater marbling scores (MS; 400 = Sm⁰; 429.4, 413.8 and 395.9). The number of health treatments significantly affected the Certified Angus Beef (CAB) acceptance rate in black-hided Angus-type calves, and these rates were 18.71, 14.36 and 11.19% for NT, 1T and 2T calves, respectively. Profitability (USD/hd) was highest for NT calves, intermediate for 1T calves and lowest for 2T calves (52.45, -15.16 and -137.3, respectively). Calves that remained healthy during the feeding period had improved feedlot performance and carcass merit, and were more profitable compared with calves that were treated one or more times for disease conditions.

Key Words: health treatments, feedlot performance, carcass traits

278 Effect of lung adhesions on feedlot performance, carcass traits and profitability of beef calves fed in the Iowa Tri-County Steer Carcass Futurity. G. D. Fike¹, L. R. Corah¹, M. E. King¹, and W. D. Busby^{*2}, ¹*Certified Angus Beef LLC, Wooster, OH*, ²*Iowa State University, Ames.*

Beef calves (n = 47, 048) fed at 18 Iowa feedlots through the Iowa Tri-County Steer Carcass Futurity over eight years (2002-09) were used to evaluate the effect of lung adhesions on feedlot performance, carcass traits and profitability. A common diet was fed and similar implant and health programs were administered to all calves. Calves were sorted and harvested when visually determined to have one cm of fat cover. Evidence of lung adhesions was visually determined at harvest in the abattoir. Unless otherwise stated, each pair of means for each outcome was different ($P < 0.0001$). Calves whose carcasses had evidence of lung adhesions (LA) had a 2.2 times greater health treatment rate and a higher health treatment cost per head than calves without lung adhesions (WO; 5.29 vs. 12.23 USD). WO calves had heavier mean delivery and adjusted final weights and were on feed for fewer days than LA calves (292.4 vs. 288.7 kg; 534.5 vs. 527.3 kg; and 169 vs. 176 d, respectively). WO calves gained weight at a higher rate than LA calves (1.45 vs. 1.37 kg/d), but lung adhesions had no effect on F:G ($P = 0.1005$). The mean HCW of WO calves was 9.9 kg

heavier than LA calves. WO calves also had more rib fat (1.13 vs. 1.08 cm) and larger ribeye areas (79.94 vs. 78.52 cm²) compared with LA calves. Marbling score (400 = Sm⁰) was greater in WO calves at 426.6 than in LA calves at 410. Lung adhesions reduced the Certified Angus Beef (CAB) acceptance rate in black-hided Angus-type calves (12.46 vs. 18.12%). Cost of gain was lower (1.39 vs. 1.48 USD/kg gain) and profit was higher (45.27 vs. 1.65 USD/hd) in WO calves compared with LA calves. Calves with evidence of lung adhesions after harvest had higher health treatment costs, poorer feedlot performance, lighter final live and hot carcass weights, lower marbling scores and made less money than those who did not.

Key Words: lung adhesions, feedlot performance, carcass traits

279 Effects of a dietary antioxidant on performance and carcass characteristics of feedlot cattle fed WDGS or high grain diets. J. P. Moore*¹, J. T. Vasconcelos^{1,2}, G. E. Erickson¹, S. A. Furman², M. Andersen³, and C. N. Macken⁴, ¹University of Nebraska, Lincoln, ²University of Nebraska, Panhandle Research and Extension Center, Scottsbluff, ³Novus International, Inc., St. Louis, MO, ⁴Performance Plus Liquid, Palmer, NE.

Wet distillers grains with solubles (WDGS) contain high levels of unsaturated fatty acids that are prone to oxidation, and contribute to the load of free radicals in the animal. Dietary antioxidants may control excessive lipid oxidation and decrease these negative effects by reducing the peroxidation of fatty acids. A finishing study was conducted to evaluate the effects of feeding a dietary antioxidant (ethoxyquin and tertiary-butyl-hydroquinone; AOX) in beef cattle fed dry-rolled corn-based finishing diets containing 0 or 30% WDGS. British × Continental steers (n = 467; initial BW = 353 kg ± 29kg) were blocked by BW (8 blocks), stratified within block, assigned randomly to 32 pens (14 - 15 steers/pen) and 4 dietary treatments were assigned randomly to pens (8 pens/treatment). The mean of 2-d weights was used for initial BW. Treatments were arranged in a 2 × 2 factorial, which included 0% or 30% WDGS, and 0 or 150 ppm AOX. Data were analyzed as a RCBD using the MIXED procedure of SAS. No WDGS level × AOX level interaction was observed ($P \geq 0.28$); therefore, only main effects were evaluated. Final BW, DMI, ADG, G:F, HCW, 12th rib fat, and YG increased ($P < 0.01$) with 30% WDGS inclusion. Smaller ($P = 0.05$) LM area (92.8 cm² to 90.4 cm², for 0 and 30% WDGS, respectively) was observed with the inclusion of 30% WDGS. No differences were observed between treatments for marbling scores ($P = 0.29$) or the distribution of USDA QG categories ($P \geq 0.13$) for WDGS inclusion. No difference was observed in performance ($P \geq 0.19$) or carcass characteristics ($P \geq 0.43$) with the inclusion of AOX. The inclusion of WDGS increased final BW by 7%, ADG by 16% and G:F by 11%. The inclusion of a dietary antioxidant had no effect on performance or carcass characteristics.

Key Words: ethoxyquin, tertiary-butyl-hydroquinone, wet distillers grains plus solubles

280 Beta acid extracts of hops: Effects on ruminal metabolism and apparent total tract digestibility of high-concentrate diets. S. Uwituze*¹, J. M. Heidenreich¹, J. J. Higgins¹, S. Garden², and J. S. Drouillard¹, ¹Kansas State University, Manhattan, ²John I. Haas, Inc., Washington, DC.

Ruminally cannulated crossbred Angus steers (n = 14; 410 ± 8 kg BW) fed finishing diets were used to evaluate effects of beta acid extracts

(BA) derived from hops (*Humulus lupulus*) on ruminal fermentation, apparent total tract diet digestibility, and plasma concentrations of fatty acid methyl esters (FAME). The study was a replicated, balanced incomplete block design with 7 treatments: control (no additives); monensin fed at 300 mg/d; or BA fed at 10, 80, 160, 240, or 300 mg/d. Monensin and BA were ruminally dosed daily before feeding. Steers were randomly assigned to treatments and allowed ad libitum access to clean water and flaked corn finishing diets in individual pens. Experimental periods (4) each consisted of a 21-d acclimation phase and 3-d sample collection phase. Ruminal digesta and fecal samples were collected at 2-h intervals to encompass 24 h post feeding. Ruminal pH and concentrations of ruminal NH₃ and VFA were determined for each sample point. Ruminal eubacteria, *Streptococcus bovis* and total methanogens were enumerated by quantitative rt-PCR. Apparent total tract digestibilities of DM, OM, NDF, CP, starch, and ether extract were estimated using chromic oxide as an indigestible marker, and FAME were measured via gas chromatography. There were no treatment effects ($P \geq 0.15$) on counts of ruminal total bacteria, *Streptococcus bovis*, or methanogens. Treatments did not alter VFA ($P \geq 0.20$) or A:P ratio ($P \geq 0.50$). Steers dosed with monensin tended ($P = 0.12$) to have lower ruminal pH compared to control steers. Feeding BA increased ruminal NH₃ compared to control steers (quad, $P < 0.10$) and steers fed monensin ($P < 0.11$). There were no treatment effects ($P \geq 0.20$) on intake or digestibilities of DM, OM, NDF, starch, CP, or ether extract. Compared to the control diet, feeding monensin or BA yielded lower plasma concentrations of myristic acid ($P < 0.05$), but other fatty acids were unaffected by treatment.

Key Words: digestibility, hops, ruminal fermentation

281 Effect of feeding corn modified to contain amylase on performance and carcass characteristics of feedlot steers. J. P. Schoonmaker*¹, M. E. Persia², and D. C. Beitz¹, ¹Iowa State University, Ames, ²Syngenta Biotechnology, Research Triangle Park, NC.

The production of ethanol from corn grain requires large amounts of α -amylase enzyme to convert corn starch to smaller polysaccharides and reduce viscosity. Currently, α -amylases used to accelerate this conversion are produced using a microbial system increasing overall costs. A new corn variety has been developed through genetic modification that expresses a thermotolerant α -amylase that is able to process the corn starch without need for addition of exogenous α -amylase. As this product was developed to be active at the high temperatures during the ethanol production system, the objective of this research was to determine performance responses in feedlot cattle fed different concentrations of this amylase-containing corn. Seventy-two Angus cross yearling steers (init. BW 349 kg ± 1.1 kg) were allotted by BW to 3 treatments (4 pens per treatment) to determine the effect of amylase corn concentration (0, 10, 20 % diet DM) on growth performance and carcass characteristics of feedlot steers. The balance of the diets consisted of non-amylase corn, 20% modified distillers grains, and 12% grass hay. Corn was dry-rolled. Steers were implanted on d 0 with Component TE-S and were slaughtered at a common final BW. Final BW was similar among treatments and averaged 603 kg ($P > 0.79$). Average daily gain (1.95, 1.95, 1.92 kg/d), daily dry matter intake (11.2, 11.8, 11.6 kg/d), and feed efficiency (173, 165, 165 g/kg) did not differ ($P > 0.41$) among cattle fed 0, 10, or 20% of the diet DM as amylase corn, respectively. Hot carcass weight and dressing percentage did not differ among treatments ($P > 0.76$). Fat thickness over the 12th rib (1.09, 0.99, 0.96 cm), Longissimus dorsi area (80.3, 81.2, 82.8 cm²), yield grade (3.0, 2.9, 2.8), marbling score (331, 357, 330), and percentage of cattle grading Choice or better (73, 88, 67) did

not differ ($P > 0.29$) among cattle fed 0, 10, or 20% of the diet DM as amylase corn, respectively. In conclusion, corn genetically modified to contain amylase has no effect on performance or carcass characteristics of feedlot steers when fed at a rate of 10 or 20% of the diet DM.

Key Words: beef feedlot, amylase corn, ethanol

282 Effects of supplemental energy and protein on forage digestion and urea kinetics. E. A. Bailey*, E. C. Titgemeyer, K. C. Olson, D. W. Brake, D. E. Anderson, and M. L. Jones, *Kansas State University, Manhattan.*

We quantified effects of supplemental energy and degradable intake protein on nutrient digestibility and urea kinetics in steers given ad libitum access to prairie hay (4.7% CP). Six ruminally and duodenally cannulated steers were used in a 4×4 Latin square with 2 extra steers. Treatments, arranged as a 2×2 factorial, were dosed ruminally once daily and included: 0 or 1200 g glucose, and 240 or 480 g of casein. Each period entailed 9 d for adaptation, 4 d for total fecal and urine collections, and 1 d for ruminal and duodenal sampling. Duodenal flows were measured using acid detergent insoluble ash as an internal marker. Urea kinetics were measured using doubly labeled urea. Glucose reduced forage intake by 18% ($P < 0.01$), whereas casein level did not affect forage intake ($P = 0.69$). Ruminal NDF digestion tended ($P = 0.16$) to be decreased by glucose, and total tract digestion of NDF was depressed ($P < 0.01$) by glucose. Microbial N flow to the duodenum ($P = 0.01$) and retained N ($P < 0.01$) were increased as casein increased, but neither were affected by glucose supplementation. The urea-N entry rate was increased 50% with increasing casein ($P = 0.03$). Urinary urea-N excretion was increased by as casein increased ($P < 0.01$); moreover, gut entry rate of urea-N was numerically increased 25% by as casein increased ($P = 0.30$). The proportion of urea entry rate that was recycled to the gut decreased ($P < 0.01$) as casein increased. Glucose supplementation decreased urinary urea ($P < 0.01$), but it did not change urea entry rate ($P = 0.70$), gut entry rate ($P = 0.91$), or the proportion of urea entry rate that was recycled to the gut ($P = 0.25$). Overall, the provision of supplemental glucose decreased forage intake and digestibility. Increasing casein altered urea kinetics by increasing urea production, but the proportion of urea-N recycled to the gut was decreased.

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Key Words: forage, energy, protein

283 Effect of nitrogen supplementation and zilpaterol-HCl on urea kinetics in steers consuming corn-based diets. D. W. Brake*, E. C. Titgemeyer, and M. L. Jones, *Kansas State University, Manhattan.*

Effects of zilpaterol-HCl on urea recycling were measured in steers fed corn-based diets with N supplemented as dried distiller's grains with solubles (DDGS) or urea. Two sets of 6 steers (350 kg) were blocked into pairs based on pre-trial feed intake and used in 2 replicates. Within each replicate, 3 steers (1 randomly selected from each pair) were fed 60 mg/d of zilpaterol-HCl, whereas the remaining steers received none. Each group of 3 steers was used in a 3×3 Latin square with treatments being corn-based diets: control (9.6% CP), urea (12.4% CP), or DDGS (13.7% CP). Urea kinetics were measured using doubly labeled

urea, and microbial N was estimated from urinary excretion of purine derivatives. Dry matter and N intakes were unexpectedly greater for zilpaterol-fed steers ($P < 0.01$); DMI was not affected by diet, but N intake was greatest for DDGS and least for control. Nitrogen retention was greater ($P < 0.05$) for cattle fed zilpaterol and tended ($P < 0.10$) to be increased by N supplementation. Supplementation with DDGS numerically increased urea entry rate (37%) and gut entry of urea (36%), and these changes corresponded to 47% greater N intakes. Steers fed DDGS tended ($P < 0.09$) to have greater loss of recycled urea-N to the feces. No differences among diets were observed for microbial N reaching the intestine ($P = 0.78$) or for microbial utilization of recycled urea-N, expressed as g/d or as proportions of urea entry rate or of gut entry rate ($P \geq 0.16$). Zilpaterol-fed steers had urea entry rates that were 6% less ($P = 0.80$) and gut entry rates of urea-N that were only 2% greater ($P = 0.94$) than those not receiving zilpaterol, despite 28% greater N intakes. Estimated microbial N flow to the duodenum was greater ($P = 0.02$) for zilpaterol than control, but microbial utilization of recycled urea-N was not affected by zilpaterol ($P = 0.41$). Because urea entry rate and gut entry rate were not affected by zilpaterol, despite the greater N intakes, it appears that the amount of N available for urea production and recycling was reduced by zilpaterol.

Key Words: zilpaterol, urea recycling

284 Effects of initial body composition on carcass weight and compositional changes in heifers fed Zilmax. L. Thompson*, C. Schneider, G. Parsons, K. Miller, C. Reinhardt, and J. Drouillard, *Kansas State University, Manhattan.*

A finishing trial was conducted to determine effects of body composition on changes in carcass weight, fatness, and muscle in heifers fed Zilmax (Z). Crossbred heifers ($n=353$; 427 kg \pm 11.1 BW) were fed finishing diets consisting of combinations of steam-flaked corn and processed grain byproducts with 3% alfalfa hay and 6% corn silage. Diets provided 300 mg monensin, 90 mg tylosin, and 0.5 mg melengestrol acetate per animal daily. Cattle were stratified by initial BW and randomly assigned (within strata) to 48 concrete-surfaced pens containing 7 to 8 animals per pen. Cattle were fed once daily and had ad libitum access to feed and water. Prior to feeding Z, cattle were weighed (PreZBW) and longissimus muscle area (LMA), rump fat thickness (RMPFT), and 12th rib fat thickness (RBFT) were measured by ultrasound. ADG were calculated for the 66-d period preceding Z feeding (PreZADG), and pre-Z HCW were estimated using LMA, RBFT, and PreZBW as described by Hassen et al. (*J. Anim. Sci.*, 1991). Zilpaterol hydrochloride (8.33 mg/kg DM) was added to finishing diets beginning 23 d before harvest and withdrawn for the final 3 d on feed. PreZBW, RMPFT, RBFT, LMA, PreZADG were used as independent variables in stepwise regression models to estimate effects on RBFT gain, yield grade (YG) gain, Carcass ADG, and LMA gain. RBFT gain = $-0.120 + 0.171(\text{RMPFT})$; $R^2 = 0.09$, $P < 0.01$. Carcass ADG = $-1.67 - 0.002(\text{LMA}) + 0.003(\text{PreZBW})$; $R^2 = 0.13$, $P < 0.01$. YG gain = $-2.17 - 0.003(\text{LMA}) + 0.342(\text{RMPFT}) + 0.002(\text{PreZBW}) - 0.212(\text{PreZADG})$; $R^2 = 0.28$, $P < 0.01$. LMA gain = $44.4 - 0.105(\text{LMA}) - 2.064(\text{RMPFT}) - 2.958(\text{RBFT}) + 0.025(\text{PreZBW}) + 3.702(\text{PreZADG})$; $R^2 = 0.58$, $P < 0.01$. Estimates of initial body composition bear little relationship to changes in fatness or carcass weight that manifest during the Zilmax feeding period. Increases in LMA were more pronounced in leaner, heavier heifers with larger loin eye areas.

Key Words: zilpaterol, feedlot, carcass

285 Performance of finishing beef steers in response to anabolic implant dose and zilpaterol hydrochloride. S. L. Parr^{*1}, K. Y. Chung¹, M. L. Galyean¹, J. P. Hutcheson², N. DiLorenzo¹, K. E. Hales¹, M. L. May¹, M. J. Quinn¹, D. R. Smith¹, and B. J. Johnson¹, ¹Texas Tech University, Lubbock, ²Intervet / Schering-Plough Animal Health, De Soto, KS.

British × Continental steers (n = 168; 7 pens/treatment; initial BW = 362 kg) were used to evaluate the dose of trenbolone acetate (TBA) and estradiol-17β (E₂) and feeding of zilpaterol hydrochloride (ZH) on performance and carcass characteristics. A randomized complete block design was used with a 3 × 2 factorial arrangement of treatments. Main effects were implant (no implant [NI]; Revalor-S [REV-S; 120 mg TBA + 24 mg E₂]; and Revalor-XS [REV-X; 200 mg TBA + 40 mg E₂]) and ZH (0 or 8.3 mg/kg of DM for 20 d with a 3-d withdrawal before harvest). Steers were fed for 153 or 174 d depending on block. No implant × ZH interactions occurred for cumulative performance data. Overall final BW (591, 632, and 650 kg for NI, REV-S and REV-X, respectively), ADG (1.4, 1.7, and 1.8 kg) and G:F (0.16, 0.18 and 0.19) were increased ($P < 0.05$) as TBA and E₂ dose increased. Implanting increased ($P < 0.05$) DMI, but DMI did not differ ($P > 0.10$) for REV-S and REV-X (8.8 for NI vs. 9.4 kg/d for the 2 implants). From d 1 to 112 of the feeding period, implanting increased ($P < 0.05$) ADG and G:F, but REV-S and REV-X did not differ ($P > 0.10$). From d 112 to end, ADG was increased (19%; $P < 0.05$) and G:F was greater (18%; $P < 0.05$) for REV-X vs. REV-S. Carcass-adjusted final BW (614 vs. 643 kg for 0 and 8.3 mg/kg ZH respectively), ADG (1.5 vs. 1.7 kg/d), and G:F (0.17 vs. 0.19) were increased ($P < 0.05$) by ZH. Hot carcass weight was increased ($P < 0.05$) by both ZH (390 vs. 409 kg) and implant, with REV-X resulting in the greatest response (376 for NI vs. 404 and 419 kg for REV-S and REV-X respectively; $P < 0.05$). An implant × ZH interaction ($P = 0.05$) occurred for dressing percent (DP). Without ZH, implanting increased DP, but DP did not differ ($P > 0.10$) for REV-X and REV-S. With ZH, REV-X increased (1.7%; $P < 0.05$) DP vs. NI and REV-S. Marbling score, 12th-rib fat, and KPH were not affected ($P > 0.10$) by implant or ZH. A greater dose of TBA and E₂ in combination with ZH increased HCW and steer performance in an additive manner, suggesting a different mechanism of action for ZH and steroidal implants.

Key Words: beef steers, estradiol-17β, zilpaterol hydrochloride

286 Comparison of a single Revalor XS implant with a Synovex Choice-Synovex Plus implant combination on feedlot steer performance and carcass characteristics. G. I. Crawford^{*1}, R. Gilland², C. G. Campbell³, and D. Fedders³, ¹University of Minnesota Extension, Hutchinson, ²Gilland Feedlot, Morgan, MN, ³Fort Dodge Animal Health, Overland Park, KS.

Crossbred beef steers (n = 751; initial BW = 319 ± 8 kg) were utilized in a commercial feedlot experiment to compare the effect of a single dose of Revalor XS (200-mg trenbolone acetate, 40-mg estradiol; REV with a Synovex Choice (100-mg trenbolone acetate, 14-mg estradiol benzoate) followed by Synovex Plus (200-mg trenbolone acetate, 28-mg estradiol benzoate; SYN) combination on feedlot steer performance and carcass characteristics. At feedlot arrival, steers were stratified by BW and allotted to 8 pens, with 6 pens of 72 to 75 head and 2 pens of 144 to 145 head. Pens were assigned randomly to treatment within pen size, with 4 pens/treatment. Steers were fed a finishing ration containing (DM-basis) 51% corn earlage, 30% modified distillers grains, 16% dry-rolled corn, and 3% supplement. The experiment began at initial implant, and re-implant for SYN steers occurred, on average, 80 d after

initial implant. Cattle were harvested in paired groups of SYN and REV from the same initial implant date, and carcass characteristics were measured after a 48-h chill. Days on feed ranged from 159 to 185 d and averaged 174 d. Carcass-adjusted final BW averaged 594 and 582 kg for SYN and REV, respectively ($P = 0.17$). Average daily gain tended ($P = 0.07$) to be greater with SYN (1.58 kg) than with REV (1.52 kg). No treatment differences were observed for DMI ($P = 0.24$) or G:F ($P = 0.41$). Percentage of carcasses grading USDA Choice or higher was greater ($P = 0.004$) for REV (68.7%) than SYN (55.9%). Percentage of carcasses grading USDA Yield Grades (YG) 1 and 2 was greater ($P = 0.04$) with SYN (44.4%) than with REV (32.8%). No treatment differences ($P > 0.13$) occurred for LM area, 12th rib fat thickness, marbling score, percentage of carcasses grading USDA YG 3 or USDA YG 4 and 5. Results indicate steers implanted with a Synovex Choice-Synovex Plus combination tended to have greater ADG, and also produced a greater percentage of USDA YG 1 and 2 carcasses and a lower percentage of carcasses grading USDA Choice and higher than steers receiving a single Revalor XS implant.

Key Words: beef steers, beedlot performance, implants

287 Effect of hide color and percentage Angus on feedlot performance and carcass traits in beef calves. L. R. Corah^{*1}, G. D. Fike¹, M. E. King¹, and W. D. Busby², ¹Certified Angus Beef LLC, Wooster, OH, ²Iowa State University, Ames.

To determine the effect of hide color (n=47,747) and percentage Angus (n=30,743) on feedlot performance and carcass traits, data on calves from 19 states and fed at 18 Iowa feedlots in the Iowa Tri-County Steers Carcass Futurity (2002-2009) were analyzed. All calves received a common diet, similar implant and health program and were sorted and harvested when visually determined to have one cm of fat cover. Upon arrival, calves were classified as black-hided (B; n=35,387) or non-black-hided (NB; n=12,360). Percentage Angus, based on sire and dam information, was low (L; n=7,931), half (H; n=6,429), three-quarters (¾; n=6,473) and straight (S; n=9,910). Percentage Angus, feedlot ADG (kg/d), mortality rate (%) and morbidity rate (%) were 72.1, 1.46, 1.18 and 16.95; and 23.4, 1.4, 2.31 and 20.74 for B and NB calves, respectively ($P < 0.05$). Percentage Prime, Choice, Select and Standard quality grades were 1.17, 70.33, 26.65 and 1.85; and .4, 53.09, 41.59 and 4.92 for B and NB carcasses, respectively ($P < 0.05$). Percentage Angus, Feedlot ADG (kg/d) and morbidity rate (%) for L, H, ¾ and S were 9.2, 1.42 and 21.69; 48.6, 1.45 and 15.49; 74.2, 1.45 and 17.29; and 99.4, 1.49 and 16.01, respectively ($P < 0.05$). Percentage Prime, Choice, Select and Standard for L, H, ¾ and S carcasses were 0.31, 51.21, 43.07 and 5.4; 0.44, 66.15, 31.32 and 2.09; 1.03, 69.3, 28.11 and 1.56; and 2.16, 79.81, 17.25 and 0.77, respectively ($P < 0.05$). Acceptance rates for black-hided Angus-type calves eligible for the Certified Angus Beef (CAB) program were 8.9, 15.8, 16.7 and 27.3 for the L, H, ¾ and S groups, respectively ($P < 0.05$). Calculated yield grade was 2.92 and 2.62 for B and NB carcasses, respectively ($P < 0.05$) and 2.56, 2.78, 2.93 and 3.03 for L, H, ¾ and S carcasses, respectively ($P < 0.05$). Feedlot performance, health and carcass quality grade were positively influenced in the black-hided and higher percentage Angus calves, while average yield grade was negatively affected.

Key Words: hide color and percentage Angus, health, feedlot and carcass performance

288 (Invited ADSA Young Dairy Scholar) Amino acid utilization in dried distillers grains with solubles based diets for dairy cows. K. Mjoun* and K. F. Kalschur, *South Dakota State University, Brookings.*

Dried distillers grains with solubles are a valuable source of protein for dairy cattle. Recent studies have shown that milk yield and DMI are similar or higher when DDGS were fed between 20 to 30% of the diet. Moreover, milk protein percentage was rarely affected when DDGS were fed up to 20%. Despite the availability of considerable data supporting that DDGS is a good source of protein, levels of its inclusion are still below potential inclusion rates partly because of concerns about possible milk protein depression. New generation DDGS may be of higher protein quality than commonly thought. In fact, there are indications that both dietary Lys concentration and amount of absorbable AA from DDGS are greater than values used in most feed formulation systems. The objectives of our work were to evaluate the quality and feeding of different DDGS products to cows in different stages of lactation. First, we utilized the arterio-venous technique to assess the utilization of AA in diets having different concentrations and types of DDGS (regular and reduced-fat DDGS). Second, using the modified 3-step in vitro procedure, we estimated intestinal digestibility of CP and AA for different DDGS including regular, reduced-fat, high protein, and modified wet distillers grains. Results conclude that DDGS are a highly digestible source of RUP, but a poor source of absorbable Lys. Different DDGS can be efficiently fed up to 20% of the diet of early and mid lactation cows without affecting milk yield or components. Arterial Lys concentration decreased with the inclusion of DDGS; however, this decrease was compensated for by adaptation in mammary extraction of AA to maintain adequate milk protein synthesis when DDGS were fed up to 20%. This adaptation capacity appears to be inadequate when DDGS were fed at 30% as milk protein percentage decreased. The AA profile and digestibility of RUP may be greater than values currently used in feed formulation and improvements in AA availability may allow for greater inclusion of DDGS in dairy cow diets.

Key Words: dried distillers grains with solubles, amino acid, milk protein

289 Ensiling wet distillers grains mixed with corn stalks and its feeding value for Holstein heifers. J. L. Anderson*¹, K. F. Kalschur¹, A. D. Garcia¹, A. R. Hippen¹, D. J. Schingoethe¹, D. H. Kleinschmitz², and D. P. Casper², ¹*South Dakota State University, Brookings*, ²*Agri-King Inc., Fulton, IL.*

The characteristics and feeding value of wet corn distillers grains with solubles (WDGS) ensiled with corn stalks (CS) were evaluated in two experiments. A mix of 66.7 % WDGS and 33.3 % CS (as-fed) was ensiled in two silo bags. One was left untreated (U) and one was treated (T) with a preservative (Silo-King GPX, Agri-King, Inc.) at a rate of 1 kg/1000 kg. Silos were sampled for analysis on d 0, 7, 14, and 21. The ensiling study was followed by a 6-wk feeding study using 12 Holstein heifers (initial BW of 225.7 ± 3.03 kg) assigned to one of three diets in a RCBD. On a DM basis, treatment diets were: 1) a control (C) of 30.3% corn-soybean meal grain mix and 69.7% alfalfa and orchard grass hay 2) 99% U and 1% mineral mix, and 3) 99% T and 1% mineral mix. Intakes were measured daily. Measurements of hip and wither heights, body length, and heart girth, BCS, and BW were taken 2 d at the beginning and end of the study. Total tract digestibilities were determined in wk 6, by feeding titanium dioxide and collecting fecal samples. In the ensiling

study, treatments were similar ($P > 0.05$) in DM (40.1 and 41.1% for U and T, respectively), CP (17.9 and 17.2% of DM), NDF (53.9 and 55.4% of DM), ADF (34.8 and 35.4% of DM), pH (4.13 and 4.12), lactic acid (3.31 and 3.45% of DM) and acetic acid (1.68 and 2.11% of DM). No treatment by day interactions were found. In the feeding study, measurements of wither, hip, length, girth, and BCS were similar for all heifers. DMI (12.1, 10.1, and 10.1 kg/d for C, U, and T, respectively) and ADG (0.95, 1.29, and 1.09 kg/d) were similar. However, gain:feed (0.08, 0.13, 0.11) was greater ($P < 0.05$) when fed U compared to C, but T was similar to both. Total tract digestibility of DM (55.7, 45.8, and 54.9 %) was greater ($P < 0.05$) when fed C and T compared to U. Digestibilities of NDF (37.4, 36.0, and 48.9% of DM), ADF (27.1, 32.1, and 42.4% of DM), and CP (64.6, 64.4, and 70.3% of DM) were greater when fed T compared to C and U. Ensiled WDGS with CS makes a quality feed for heifers. Inclusion of a preservative enhanced nutrient digestibility when fed to dairy heifers in this study.

Key Words: wet distillers grains, corn stalks, heifers

290 (Invited ADSA Young Dairy Scholar) Effects of rumen undegradable protein and forage composition on milk production of dairy ewes. C. Mikolayunas*, D. L. Thomas, L. E. Armentano, and Y. M. Berger, *University of Wisconsin, Madison.*

Three trials evaluated the effects of protein degradability and forage composition on milk production of ewes. In the first trial, 3 diets were formulated to provide similar energy levels and varying concentrations of rumen-degradable protein (RDP) and rumen-undegradable protein (RUP): 12% RDP and 4% RUP (12 - 4), 12% RDP and 6% RUP (12-6), and 14% RDP and 4% RUP (14 - 4). Eighteen ewes were blocked by milk yield (low and high) and randomly assigned to pens of 3 ewes each. Treatments were arranged in a Latin Square within blocks and applied to pens for 14-d periods. Across milk production levels, 12 - 6 increased ($P < 0.01$) milk and protein yield by 14 and 13%, respectively, compared to 14 - 4 and by 15 and 14%, respectively, compared to 12 - 4. In a cut-and-carry trial, 16 ewes were randomly assigned to 8 pens. Pens were randomly assigned to supplement treatments of either 0 or 0.3 kg/d Soy Pass. Within supplement, pens were randomly assigned to one of four forage treatments, including the following percentages of dry matter from orchardgrass and alfalfa: 25:75, 50:50, 75:25, and 100:0. Forage treatments were applied in a Latin Square design for 10-d periods. There was no interaction between forage and supplement treatments. Supplement tended to increase ($P < 0.10$) milk yield by 9%. Milk and protein yield increased linearly ($P < 0.01$) with increased percentage of alfalfa. In a grazing trial, 12 ewes were randomly assigned to 3 pens. Within pens, 2 ewes each were randomly assigned to receive either 0 or 0.3 kg/d of SoyPLUS. Grazing treatments were arranged in a Latin Square design and applied to pens for 10-d periods. Ewes grazed the following percentages of pure stands of orchardgrass and alfalfa by area: 100:0, 75:25, and 50:50. There was no interaction between supplement and forage treatments. Supplement tended ($P < 0.10$) to increase protein yield. Milk and protein yield increased linearly ($P < 0.05$) with increased alfalfa area. In conclusion, milk and protein yield in dairy ewes can be increased with RUP supplementation and increased alfalfa consumption.

Key Words: dairy sheep, protein degradability, forage composition

291 Effects of supplementing dairy cows with chromium propionate on milk and tissue chromium concentrations. K. E. Lloyd¹, J. W. Spears*¹, S. McLeod¹, R. S. Fry¹, K. Krafka², A. Lamptey², and V. Fellner¹, ¹North Carolina State University, Raleigh, ²Kemin AgriFoods North America, Inc, Des Moines, IA.

Research evaluating the effects of Cr supplementation on milk and tissue Cr concentrations in cattle is limited. Eight primiparous and eight multiparous Holstein cows were used to determine the effects of Cr supplementation, from Cr propionate, on milk and tissue Cr concentrations. Cows were randomly assigned by parity to either: 1) control diet or 2) 2 mg supplemental Cr/kg DM. The level of Cr supplemented in this study exceeds the permitted level by four-fold. Experimental diets were fed from approximately 30 d prepartum until at least 90 d postpartum, resulting in a minimum of 120 d exposure to supplemental Cr. The control prepartum and postpartum diets analyzed 0.48 and 0.38 mg Cr/kg DM, respectively. Milk samples were obtained from the a.m. milking on d 0 (colostrum), 7, 14, 21, 28, 42, 56, 77, 90 and on the final day of the study for Cr analysis. Cows were harvested after lactating for a minimum of 90 d and samples of liver, kidney, semitendinosus muscle, and fat were obtained for Cr analysis. Chromium was measured in feed, milk, and tissue samples using electrothermal atomic absorption spectrophotometry. Milk Cr concentrations averaged 1.7 ng/L and were affected by day ($P < 0.02$) but not by Cr or a Cr \times day interaction. Supplementation of 2 mg Cr/kg DM increased ($P < 0.01$) kidney Cr by approximately three-fold and liver Cr concentrations by roughly two-fold. Chromium concentrations in muscle and fat were not affected by Cr supplementation. In summary, supplementation of Cr propionate at a level of 2 mg Cr/kg DM did not affect Cr concentrations in milk, muscle, or fat, the major bovine products consumed by humans.

Key Words: chromium, milk, tissue

292 Ames assay, mouse lymphoma assay, and mouse micronucleus assay confirm chromium methionine to be nongenotoxic. T. L. Ward*, M. Hansen, and P. A. Stark, Zinpro Corporation, Eden Prairie, MN.

Chromium (III) is a required trace mineral, functioning to facilitate glucose uptake purportedly via enhanced efficiency of insulin. While considered a required nutrient, there have been some reports regarding genotoxicity of chromium tripicolinate. Therefore, Zinpro was prompted to evaluate chromium methionine (CrMet) for genotoxicity in a standard battery of three assays according to FDA GLP requirements and toxicity guidelines. An in vitro Ames Assay was conducted to quantify the frequency of reverse mutations at the his locus of 4 different *Salmonella typhimurium* strains and an *Escherichia coli* strain in the presence and absence of Aroclor-induced rat liver S9 at levels up to 5000 ug CrMet per plate. An in vitro Mouse Lymphoma cell Assay (MLA) established genotoxicity based on quantitation of forward mutations at the thymidine kinase locus of L5178Y mouse lymphoma with increasing doses up to 5000 ug CrMet/mL. Finally, an in vivo Mouse Micronucleus Assay (MMA) was conducted to evaluate the potential of the CrMet to increase the incidence of micronucleated polychromatic erythrocytes in bone marrow of male and female ICR mice orally dosed with levels up to 2000 mg CrMet/kg BW. All tests included appropriate vehicle controls and assay specific positive controls. The outcome of all three assays was negative, indicating no genotoxicity of CrMet. In the Ames assay, no positive mutagenic response was observed. Neither precipitate nor appreciable toxicity was observed. In the MLA, no cloned cultures exhibited mutant frequencies ≥ 90 mutants per million clonable cells

over that of the solvent control. There was no concentration-related increase in mutant frequency. In the MMA, no increase in the incidence of micronucleated polychromatic erythrocytes were observed in the test article groups relative to the respective vehicle control groups in male or female groups at 24 or 48 hours after dose administration ($P > 0.05$, Kastenbaum-Bowman Tables). In conclusion, chromium methionine was found to be non-genotoxic in vivo or in vitro.

Key Words: chromium, chromium methionine, genotoxicity

293 Effects of nutritional plane and selenium supply during gestation on circulating non-esterified fatty acid and thyroid hormone concentrations in first-parity ewe lambs. A. M. Meyer*, D. R. Montonye, J. J. Reed, L. P. Reynolds, D. A. Redmer, J. S. Caton, and K. A. Vonnahme, Center for Nutrition and Pregnancy, Department of Animal Sciences, North Dakota State University, Fargo.

To investigate the effects of nutritional plane and Se supply during gestation on maternal circulating NEFA, thyroxine (T_4), and triiodothyronine (T_3) concentrations, 42 Rambouillet ewe lambs (240 ± 17 d of age, 52.1 ± 6.2 kg), were allocated to a 2×3 factorial design. Factors included Se (adequate Se [ASe, $11.5 \mu\text{g/kg BW}$] or high Se [HSe, $77 \mu\text{g/kg BW}$]) 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 individually in a temperature-controlled facility. Lambs were removed at parturition, and ewes were transitioned to diets providing 100% of NRC requirements and milked for 20 d. From d 67 of gestation until parturition, plasma NEFA were increased ($P \leq 0.01$) in ewes fed the RES diet. On d 123 of gestation, CON fed ewes also had greater ($P = 0.02$) NEFA than HIGH. Ewes fed the RES diet had decreased ($P = 0.05$) T_4 from d 81 of gestation until parturition. Additionally, T_4 was greater ($P = 0.01$) in HIGH than CON on d 137. Ewes fed the HIGH diet had increased ($P = 0.03$) T_3 on d 67 and 123 of gestation. On d 109, RES also had less ($P = 0.04$) T_3 than CON. Gestational Se levels did not affect ($P > 0.39$) T_4 or T_3 during gestation, but ewes fed ASe had increased ($P = 0.02$) NEFA on d 95 of gestation. Serum T_4 was increased ($P = 0.04$) in HIGH at 3, 6, and 24 h postpartum, whereas T_4 was decreased ($P = 0.03$) at 3, 6, and 12 h in RES. At 6 h post-partum, RES also had decreased ($P = 0.04$) T_3 . Ewes previously fed the HIGH diet during gestation had increased ($P < 0.05$) T_3 on d 3 and 7 and increased ($P < 0.05$) T_4 from d 1 to 14 of lactation. By d 20, NEFA were greater ($P = 0.01$) for ewes previously fed HIGH than CON. Previous Se supply had no effect ($P > 0.26$) on NEFA during lactation, but T_3 was greater ($P = 0.01$) for ASe than HSe on d 7. Results of this study indicate that gestational nutritional plane and, to some extent, dietary Se supply, continue to affect metabolism during early lactation, even when ewes are fed a similar postpartum diet.

Key Words: energy metabolism, nutrition, thyroid hormones

294 Effects of feeding site and hay processing on dry matter intake and hay waste by wintering beef cows. J. P. Jaderborg*¹, S. L. Bird², G. I. Crawford³, R. Walker⁴, B. J. Funnell², and A. DiCostanzo¹, ¹University of Minnesota, St. Paul, ²North Central Research and Outreach Center, Grand Rapids, MN, ³Regional Extension Office, Hutchinson, MN, ⁴Regional Extension Office, Andover, MN.

An experiment was conducted to evaluate how hay placement (in a structure such as a bunk or hay ring vs. on the ground) or processing (ground vs. whole) affected hay DMI and waste by wintering beef cows. Late

gestating Angus cows (n = 48; 626 kg) were stratified by BW and age to one of four groups. Groups were then orthogonally allotted into 10-d treatment periods in a 4 X 4 Latin Square design with four treatments resulting from the factorial arrangement of placement and processing. Treatments included delivery of hay in a ring or bunk (S) either whole (W) or processed (P), or on the ground (NS) as a rolled-out bale (W) or processed (P). Cows were weighed after removing feed for at least 12 h to determine group BW. Dry matter and energy required for maintenance was determined from NRC (2000) requirements, and feed offered was provided accordingly. Each treatment received a complete mineral and salt source to meet daily needs for these nutrients. Refusals were measured every 24 h by collecting and weighing random 0.093 m² samples representing 2% of the waste scatter area. Dry matter intake was not ($P > 0.05$) affected by P or S, and averaged 11.6 kg/d (1.91% BW). Expressed as a percentage of DMI, hay waste was greater ($P = 0.0003$) for cows fed hay on the ground (18.3% vs. 4.7%). Organic matter of refused or wasted hay was lower ($P = 0.0005$) for cows fed ground hay (86.0% vs. 92.9%). Cows fed whole hay in a ring consumed the least ($P < 0.01$) amount of mineral (0.39 vs. 0.69 kg/d). Cows fed hay on the ground wasted more, and consumed the same DM as those fed in a structure. Mineral intake appeared to be influenced by whether cows needed to form a group (hay ring) or they could scatter to consume hay.

Key Words: cow, hay, intake

295 Effects of pasture management and off-stream water on temporal/spatial distribution of cattle in cool-season grass pastures. K. A. Schwarte*, J. R. Russell, and D. G. Morrical, *Iowa State University, Ames.*

An experiment was conducted to monitor the effects of microclimatic conditions on cow distribution relative to a stream in cool season grass pastures under different grazing management practices during the 2008 grazing season. Six 12.1-ha pastures, primarily containing smooth bromegrass and bisected by a 141-m reach of a stream, were stocked with 15 fall-calving Angus cows and grazed by continuous stocking with unrestricted stream access (CSU), continuous stocking with stream access restricted to 4.9-m wide stabilized crossings (CSR), or rotational stocking (RS). A GPS collar fitted on one cow per pasture recorded cow position every 10 min for two weeks monthly from May through September. To determine the effects of off-stream water on cow distribution, alternative water was provided on both sides of the stream at a minimum of 241 m away from the stream for one of the two weeks. At each 10 min interval, a cow's position was defined as being in one of four zones; in the stream banks (stream zone) or within 33 (33 m zone), 67 (67 m zone), or greater than 67 m feet (upland zone) from either side of the stream bank. Cattle grazing in the CSU treatment spent more time within the stream ($P < 0.05$) in June and August, and in July and September ($P < 0.10$) than cattle in the other treatments. Cattle in the CSU treatment also spent more time within the 33 m zone ($P < 0.05$) from May through July, and in September than cattle in the other treatments. There were no differences seen between CSR and RS pastures ($P > 0.10$) in the amount time spent by cattle within either stream bank or 33 m zones. The probability of cattle being in and within 33 m of the stream increased by 8.2 and 11.9% for CSR and CSU pastures, respectively, for each 1°C increase in ambient temperature. The presence of off-stream water did not alter the amount of time that cattle spent in any of the zones ($P > 0.10$). Results suggest that RS and CSR treatments can effectively reduce the amount of time cattle spend within 33 m of a stream, even during periods of warmer weather conditions.

Key Words: grazing management, GPS collars, cattle distribution

296 Forage quality and grazing performance of beef cattle grazing brown mid-rib grain sorghum residue. A. K. Watson*¹, J. R. Geis¹, W.A. Griffin¹, G. E. Erickson¹, T. J. Klopfenstein¹, R. B. Mitchell², and J. F. Pedersen², ¹*University of Nebraska, Lincoln*, ²*USDA, ARS, Lincoln, NE.*

Residue from two grain sorghum hybrids, the control AWheatland × RTx430 (CON) and its near-isogenic hybrid containing the brown mid-rib gene *bmr12* (BMR), were compared in a 2 year study. Forty-eight steers (236 ± 23 kg) were assigned randomly each year to 2.12 ha paddocks (6 steers/paddock) containing BMR or CON grain sorghum residue. Steers grazed from early December until early February. Enclosures were placed in each paddock and sampled to compare residue quality when not grazed. Residue was sampled throughout the grazing period. Stem and leaf fractions were analyzed for NDF content and in vitro NDF digestibility (IVNDFD). Steers grazing BMR gained more (0.63 kg/d; $P < 0.01$) and had greater ending BW (281 kg; $P < 0.01$) than CON (0.47 kg/d and 271 kg). There was no interaction between year and treatment ($P = 0.20$). No difference in NDF content of the leaf fraction was observed between CON and BMR ($P = 0.82$), averaging 70.7% for BMR and 70.1% for CON. Leaves from BMR paddocks were 6 to 12% units and stems were 13 to 19% units more digestible than CON paddocks ($P < 0.01$) for IVNDFD. Stems and leaves from BMR paddocks had similar IVNDFD ($P > 0.05$) while stems were lower in IVNDFD compared to CON leaves ($P < 0.01$). This suggests that if stems were palatable, cattle would receive a similar amount of energy from either stems or leaves in BMR grain sorghum residue. Weather conditions and the selective grazing habits of cattle subtly influenced IVNDFD of the residue over time. In year 1, the grazed areas decreased in IVNDFD over time for both BMR and CON paddocks. In year 2 there was a quadratic effect with IVNDFD of BMR and CON being highest in the middle sampling period. In year 1 IVNDFD of grazed areas decreased more rapidly than ungrazed areas and in year 2 there were no differences between grazed and ungrazed areas. Calves grazing BMR grain sorghum residue have increased ADG due to increased fiber digestibility compared to conventional hybrids.

Key Words: beef cattle, brown mid-rib, crop residue

297 Post-weaning performance by spring and fall-born steers weaned from full access, limited access, or no access to endophyte-infected tall fescue - 2 year summary. J. Caldwell*¹, K. Coffey¹, D. Philipp¹, C. Kreibiel², B. Holland³, J. Jennings⁴, D. Hubbell, II¹, J. Tucker¹, A. Young¹, T. Hess¹, D. Kreider¹, M. Looper⁵, M. Popp¹, M. Savin¹, E. Kegley¹, ¹*University of Arkansas, Fayetteville*, ²*Oklahoma State University, Stillwater*, ³*South Dakota State University, Brookings*, ⁴*Cooperative Extension Service, Little Rock, AR*, ⁵*USDA-ARS Booneville, Booneville, AR.*

Replacing *Neotyphodium coenophialum*-infected tall fescue (E+) with non-toxic endophyte-infected fescue (NE+) may improve calf weaning BW (WW), but the impacts on post-weaning performance and carcass traits have not been reported. Crossbred cows of similar breeding (n = 178; resulting in 166 steers) were stratified by weight and age within fall (F) and spring (S) calving seasons and allocated randomly within calving season to 1 of 14 groups to determine the extent of having limited access to NE+ prior to weaning affected post-weaning performance. The groups were assigned randomly to 5 treatments: 1) F on 100% E+ (F100; n = 3); 2) S on 100% E+ (S100; n = 3); 3) F on 75% E+ and 25% NE+ (F75; n = 3); 4) S on 75% E+ and 25% NE+ (S75; n = 3); and 5) S on 100% NE+ (NE100; n = 2). Adjusted and actual WW, feedlot total gain

and efficiency, dressing percent, marbling score, and percentage choice were greater ($P < 0.05$) from F vs. S, but BW at shipping, feedlot ADG, ribeye area, and YG, were greater ($P < 0.05$) from S vs. F. Adjusted and actual WW were greater ($P < 0.05$) from S75 and F75 vs. S100 and F100, but percentage choice was greater ($P < 0.05$) from S100 and F100 vs. S75 and F75. Adjusted and actual WW, BW at shipping, final BW, feedlot ADG, and hot carcass weights were greater ($P < 0.05$) from NE100 vs. S75. Therefore, a fall-calving season for cows grazing E+ may benefit steer WW, feed efficiency, and percentage choice. Limited use of NE+ may enhance steer WW, but may not offset other negative impacts of pre-weaning exposure to E+ on post-weaning measurements of spring-born steers.

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Key Words: novel endophyte, steers, tall fescue

298 (Invited) The challenges of delivering direct fed microbials to ruminants. M. R. Garner*, *MicroBios Inc., Ithaca, NY.*

It is widely accepted that the administration of direct-fed microbials (DFM) can improve animal production performance and can reduce the presence of pathogens such as *E. coli* O157:H7 in cattle feces. It is also well documented in the literature that DFM effectiveness can be dose dependant. Thus, sufficient viable microorganisms numbers must be delivered to elicit beneficial effects upon the host. Unfortunately, the number of viable cells delivered to the animals in commercial settings is often disregarded or improperly calculated due to the lack of viable DFM monitoring. Application methods of DFM to animal feed can have a tremendous impact upon microbial viability. The most challenging steps of delivery involve exposure of live microorganisms to the wide range of environmental conditions prior to reaching the animal. Some of these detrimental conditions include: ambient temperature, atmospheric humidity, feed temperature (e.g., steam flaked or rolled corn), milk replacer temperature, feed dry matter content, feed micro-osmolality, antibiotic concentrations, and water quality. The sensitiveness of certain live DFM organisms make uniform administration more difficult in the dairy and feedlot industries than ionophores, antibiotics, beta-agonists, and hormones. In many cases, injurious environmental factors can be addressed through site-specific application modifications whether using wet or dry application methods. For this to be possible; however, the sites of microbial loss must first be identified. As a solution to improving the delivery of live microbials, we suggest the diagnostic determination of live bacteria be implemented at the research and industry-wide levels. We feel the use of a diagnostic tool that allows for rapid strain-specific enumeration of target DFM populations is critical to: i) illuminate the modes of actions of DFM, ii) elucidate the proper microbial dosage specific to each type of ruminant, iii) determine the impact of application methods upon viability, iv) assess the effect that environmental factors have upon viable cell populations, and ultimately v) perform accurate and precise application of microbials to feedstuffs of ruminants in commercial settings.

Key Words: ruminant, DFM

299 (Invited) Effects of direct-fed microbials on health and development of pre-ruminant dairy calves: An assessment. A. F. Kertz*, *ANDHIL LLC, St. Louis, MO.*

Average U. S. dairy calf mortality is 8 to 10% according to National Animal Health Monitoring System (NAHMS) surveys. There is increasing longer term evidence that calves are affected by a good or bad start. Administering 3.8 vs 1.9 L colostrum at the first feeding decreased treatment costs, increased ADG pre-breeding, and increased milk yield for the first and second lactations by 11 and 17%, respectively. The NAHMS 2007 data indicated colostrum is administered poorly. Recent studies have found colostrum fed to calves had excessive levels of total bacteria and coliform. Recent data analysis has shown for every kg ADG within the preweaning range of 0.13 to 1.23, there was an increase of 1,083 kg more milk in the first lactation. Hence there are longer term productive and economic benefits to young calf health and performance. The U.S. FDA defines direct fed microbials (DFM) as containing live microorganisms. There are limited published data of their impact on preweaned dairy calves. The most common DFM that have been evaluated are lactobacilli and bacilli. In several studies *L. acidophilus* added to milk or milk replacer increased fecal shedding by calves, increased lactobacilli in small and large intestines, and contributed to some decreases in coliform. A culture derived from calves was more effective than derived from other sources. A *Bacillus subtilis* tended to increase ADG and feed efficiency in one study, but did not show wither height or heart girth differences. A field trial failed to show significant differences among a control or added viable or nonviable microbial cultures. These and other trials varied considerably in colostrum status of calves, housing and bedding, stress factors, and feeding programs in addition to source and amount of DFM used. Potential DFM use for dairy calves depends on how they would be used: daily or as needed for health issues, dose and source of bacteria, type of bacteria and their characteristics, and what agents these bacteria may possess or contribute to the calf's health and performance.

Key Words: dairy calves, direct fed microbials, performance

300 (Invited) Direct-fed microbials for growing and finishing cattle: Impact on growth performance and health. M. S. Brown*¹ and C. R. Krehbiel², ¹West Texas A&M University, Canyon, ²Oklahoma State University, Stillwater.

Direct-fed microbials (DFM) are one broad category of technologies that can improve production efficiency by feedlot cattle. Further emphasis has been placed on DFM in the production of natural beef because a number of safe, highly efficacious products that improve production efficiency cannot be used in natural beef programs. Commercially available DFM products range from extracts of fungal cultures to viable cultures of fungi and bacteria. The data reviewed will address product efficacy, although potential customers will consider the value of service provided in addition to direct and indirect costs in product selection. The majority of products need further demonstration of their efficacy to allow identification of a rigorous estimate of expected changes in growth performance and reach a clear conclusion on the value of a specific product. A *Saccharomyces cerevisiae* live yeast product (Ivy Natural Solutions, Pro-Ternative) and a *Saccharomyces cerevisiae* culture product (Diamond V Mills, XP) have reduced morbidity by stressed calves, whereas an *Aspergillus oryzae* extract (Biozyme, Inc., Amaferm) and another *Saccharomyces cerevisiae* live yeast product (Alltech Inc., Yea-Sacc) may be expected to enhance growth rate of growing cattle fed higher forage diets by approximately 3% or more. Data suggest

that improvements in growth performance of approximately 2.5% can be expected by finishing cattle fed bacterial products containing various strains of *Lactobacillus acidophilus* alone or in combination with *Lactobacillus plantarum*, *buchneri*, or *casei*, *Enterococcus faecium*, or *Propionibacterium freudenreichii*; however, published data are by far most clear for a specific product, Bovamine (Nutrition Physiology Corp.). Additional data are needed using diets with higher inclusions of byproduct feeds, as well as continued development to identify products or combinations of products that may aid in the control of digestive deaths, improve health, or improve growth performance.

Key Words: cattle, direct-fed microbials, growth

301 (Invited) Direct-fed microbials and preharvest food safety in beef cattle. T. G. Nagaraja*, *Kansas State University, Manhattan.*

Food borne pathogens, specifically *Escherichia coli* O157:H7, *Salmonella*, and *Campylobacter*, reside in the gastrointestinal tract of cattle. Fecal shedding of these pathogens serves as a major source of human exposure, and food borne illnesses of cattle origin are a significant public health concern. Direct-fed microbials (DFM) are widely used as feed additives in cattle to improve animal performance. Because DFM are known to beneficially alter the microbial balance in the gut, they could have impact on prevalence and fecal shedding of pathogens. The concept of excluding pathogens in the gut with the use of beneficial bacteria is called competitive exclusion (CE). The proof of concept was first demonstrated in newly-hatched chicks, which became resistant to *Salmonella* colonization following oral inoculation with gut bacteria obtained from healthy chicken. Therefore, DFM have the potential to be a simple intervention strategy to decrease the proportion of cattle harboring food borne pathogens. Effective on-farm methods to reduce or eliminate the carriage of food borne pathogens in cattle will contribute to decreased levels of human exposure via food and the environment. Most of the research on DFM as a preharvest food safety tool has targeted *E. coli* O157:H7, perhaps because the pathogen in beef is declared as an adulterant by the U. S. Food Safety Inspection Service. Although a number of DFM are available commercially, few, specifically *Lactobacillus*-based DFM, alone or in combination with *Propionibacterium* or yeast, have shown significant reduction in fecal prevalence of *E. coli* O157:H7. Presently, none of the commercial DFM products have approval for food safety use. The mechanisms of DFM antagonism on *E. coli* O157:H7 are not fully understood but likely include direct effects, mediated by inhibitory substances, or indirectly by altering the gut ecosystem to make it less hospitable for *E. coli* O157:H7 to survive and persist. Overall, DFM appear to have promise as a natural intervention strategy to reduce *E. coli* O157:H7 in cattle but further research is warranted.

Key Words: direct-fed microbials, cattle, food safety

302 Lactation response to a ruminally-protected B-vitamin product (Vicomb P+). H. Gencoglu^{1,2}, L. Ferraretto*¹, M. Akins¹, and R. Shaver¹, ¹*Department of Dairy Science, University of Wisconsin, Madison*, ²*Department of Animal Nutrition and Nutritional Diseases, Faculty of Veterinary Medicine, University of Uludag, Bursa, Turkey.*

The objective of this trial was to evaluate the lactation performance of dairy cows to a ruminally-protected B-vitamin product (Vicomb P+) added to the TMR. Sixty-four cows (169 ± 22 DIM) were stratified by breed Holstein [36] or Holstein-Jersey crossbreds [28] and parity (1st [34] or 2nd lactation and greater [30]) and randomly assigned to pens.

Treatments were applied to 8 pens of 8 lactating cows in a cross-over design with 4-wk periods; 2 wk of adaptation followed by 2 wk of data collection. The 8 pens were randomly assigned a treatment sequence (control followed by treatment or treatment followed by control). The TMR contained (DM basis) corn silage (30%), alfalfa silage (30%), rolled high-moisture shelled corn (18.9%), soybean meal (7.8%), distillers dried grains (10.4%), and mineral/vitamin/additive mixture. The control was 20 mg/cow/d ruminally-unprotected biotin in a premix, while the treatment was 3 g/cow/d Vicomb P+ (JEFO USA, Inc., Dania Beach, FL; to provide 9.6 mg biotin, pantothenic acid, pyridoxine and folic acid in a ruminally-protected form) in a premix, with both premixes in the TMR at 57 g/cow/d. Data from the last 2 wk of each period were analyzed in PROC MIXED of SAS with period, sequence and treatment as fixed effects and pen (sequence) as a random effect. Milk production, DMI, and MUN averaged 35.5 kg/d, 24.0 kg/d, and 14.7 mg/dL respectively, and were unaffected ($P > 0.10$) by treatment. Milk composition was unaffected ($P > 0.10$) by treatment, and averaged 3.96% fat and 3.34% true protein. We cannot determine whether or not cows responded to the ruminally-unprotected biotin in the control diet due to not having a negative control diet without supplemental biotin. Lack of response to the ruminally-protected B-vitamin product may be related to the relatively late stage of lactation and low milk production of the cows.

Key Words: B-vitamins, dairy cows, milk production

303 Detection of yeast cells in omasal digesta of dairy cows consuming dried distillers grains and solubles. E. Castillo-Lopez*, P. J. Kononoff, and J. L. Miner, *University of Nebraska, Lincoln.*

Purine analysis is widely used to estimate microbial crude protein (MCP) flow and this method assumes that all purines contained in feed are degraded in the rumen and that purines detected are of microbial origin. The objective of our experiment was to determine if the yeast cells (*Saccharomyces cerevisiae*) contained in dried distillers grains and solubles (DDGS) escape degradation in the rumen. Two ruminally fistulated Holstein dairy cows averaging 649 kg (SD = 42.0) and averaging 126 DIM (SD = 28.9) were sequentially fed two treatment diets during two periods of 21 days each. Treatments were 1) Control, a TMR not containing DDGS and 2) Treatment, a TMR in which DDGS were included at 30% of the diet DM. On days 20 and 21 at 0400h and 1600h omasal digesta samples were collected via a ruminal cannula. Digesta was strained through four layers of cheese cloth and total DNA was extracted from each sample in duplicate. The DNA samples were subjected to real-time PCR assay to detect the presence of yeast DNA. Forward and reverse primers and a dual labeled probe were designed to target a DNA segment contained on the second chromosome of *Saccharomyces cerevisiae*. The data were analyzed in SAS as a 2 × 2 crossover design. Real-time PCR amplification curves indicated the presence of yeast DNA in samples from both treatments. Specifically, the estimate of relative abundance of yeast DNA from digesta samples collected from animals consuming the diet containing DDGS was 9.46 ± 0.67/g DM and was significantly higher ($P < 0.01$) than that from animals consuming no DDGS, which was observed to be 0.091 ± 0.67/g DM. Results of this experiment suggest that yeast cells contained in DDGS are not completely degraded in the rumen and pass to the omasum. Consequently, the estimate of MCP may be confounded when estimated by measuring the concentration of purines in the digesta.

Key Words: DDGS, *Saccharomyces cerevisiae*, yeast DNA

304 Effects of round bale alfalfa processing type on heifer performance, forage wastage, and eating preference. S. Q. Jones^{*1}, J. M. DeRouchey¹, J. W. Waggoner¹, T. T. Marston¹, R. M. Breiner¹, and T. J. Kraus², ¹Kansas State University, ²John Deere, Ottumwa, IA.

Three experiments evaluated the effects of round bale alfalfa processing type on beef heifer performance, wastage, and preference when fed in ring feeders. A round baler (John Deere) that had the ability to cut alfalfa prior to net wrapping was used for all experiments. Conventional bales were baled with the cutter disengaged. In Exp. 1, 46 heifers (270 kg initial BW) were used in a 27-d study to evaluate performance. Heifers were offered free choice precut or conventionally-baled alfalfa hay in a 2.4 m ring feeder and fed 1.5 kg DM of wet corn gluten daily. Treatments were: 1) 1.5 × 1.2 m conventionally-baled alfalfa, and 2) 1.5 × 1.2 m precut alfalfa. There were 2 replicates per treatment. Heifers fed precut had higher (1.37 kg vs. 1.13 kg; $P < 0.01$) ADG compared to heifers fed conventional alfalfa. There was no difference (5.23 kg vs. 5.56 kg; $P = 0.70$) in calculated DMI between treatments. In Exp. 2, 46 heifers were used to evaluate the effects of baling method on forage wastage from ring feeders. Treatments were: 1) 1.5 × 1.2 m conventionally-baled alfalfa, and 2) 1.5 × 1.2 m precut alfalfa. Wastage (on the ground forage outside the feeder) was collected daily for 5 d 2.4 m surrounding the ring feeder (2.4 m diameter). Wastage was collected on 3 subsequent 5-d periods from each of 2 pens for a total of 6 replications per bale type. Overall, there was no difference ($P > 0.05$) in wastage between the two treatments. In Exp. 3, 26 heifers (305 kg) were used to evaluate preference for conventional vs. precut alfalfa offered simultaneously in different ring feeders for 2 d. Treatments were: 1) 1.2 × 1.2 m conventionally-baled alfalfa and 2) 1.2 × 1.2 m precut alfalfa. Two pens containing 13 heifers each were used to measure performance with 2 pens used in 2 subsequent 2 d periods and 1 pen used in a single subsequent period. Thus, there were 5 replicates per treatment. There was no difference (4.7 vs. 3.9 kg/d; $P = 0.48$) in calculated DMI between precut and conventional alfalfa. In summary, heifers fed precut vs. conventional alfalfa in ring feeders had improved ADG, but processing type did not influence wastage or eating preference.

Key Words: alfalfa, preference, wastage

305 Comparison of feeding and mixing characteristics of precut, conventional and tub ground alfalfa or cornstalks in a TMR. S. Q. Jones^{*1}, J. M. DeRouchey¹, J. W. Waggoner¹, T. T. Marston¹, R. M. Breiner¹, and T. J. Kraus², ¹Kansas State University, ²John Deere, Ottumwa, IA.

Two experiments evaluated the feeding and mixing characteristics of precut, conventional, and tub ground alfalfa or cornstalks in a horizontal TMR. Bales (1.5 × 1.2 m) for both experiments were baled using a round baler (John Deere) that had the ability to cut the material being baled prior to wrapping. Conventional bales were baled with the cutter disengaged. In both experiments there were 5 replicates per trt with 5 blocks composed of 3 d each, for a total of 15 d. One treatment was randomly fed daily for each 3-d blocks. Samples of TMR were taken during the first, middle, and last third of the discharge for analysis. Orts remaining in the bunk were collected and weighed before the next feeding period. In Exp. 1, 75 bulls (317 kg initial BW) were used to evaluate the effects of alfalfa hay processing methods on TMR diet mix uniformity and feed refusal. The trts were a TMR that contained either conventionally, precut or tub ground alfalfa. Diet chemical analysis revealed no mixer discharge site × bale type interactions ($P > 0.80$). Diet NDF was higher ($P < 0.05$) when conventional vs. tub ground alfalfa was used. Diet CP

and DM was not affected by processing type ($P < 0.28$). Samples in the last third discharge had greater ($P = 0.03$) ADF and NDF than samples in the beginning third. In Exp. 2, 60 heifers (initially 332 kg BW) were used to evaluate the effects of varying cornstalk processing methods on TMR diet uniformity and feed refusal. The trts were TMR that contained either conventionally, precut or tub ground cornstalks. Chemical analysis revealed no mixer discharge site × bale type interactions ($P > 0.31$). Bale processing technique did not affect ($P > 0.11$) diet DM, CP, ADF, and NDF. Samples in the first third of the discharge had lower ($P = 0.02$) DM and higher ($P = 0.04$) CP than samples in the last third. Samples in the middle third discharge had lower ($P = 0.01$) ADF and NDF and higher ($P = 0.01$) CP compared with samples in the last third discharge. Feed refusal was similar among all 3 treatments ($P > 0.25$). Diet uniformity was minimally affected by forage processing method, but was influenced by discharge location.

Key Words: alfalfa, cornstalk, TMR

306 Comparison of mixing characteristics of precut and conventional alfalfa and cornstalk bales in a vertical mixer. S. Q. Jones^{*1}, J. M. DeRouchey¹, J. W. Waggoner¹, T. T. Marston¹, R. M. Breiner¹, and T. J. Kraus², ¹Kansas State University, ²John Deere, Ottumwa, IA.

Two experiments were conducted to compare the mixing characteristics of precut or conventionally processed alfalfa and cornstalk round bales. Bales for both experiments were baled using a round baler (John Deere) that had the ability to cut the material being baled prior to wrapping. Conventional bales were baled with the cutter disengaged. Mixing time was measured when the bale entered the vertical mixer (12 m³ Roto-Mix Vertical Express) until the bale core was broken apart. In Exp. 1, one field of alfalfa was swathed and baled as 1) 1.5 × 1.2 m precut bales, 2) 1.5 × 1.2 m conventional bales, 3) 1.8 × 1.2 m precut bales, and 4) 1.8 × 1.2 m conventional bales. There were 8 replicates for trts 1, 2 and 3 with 7 replicates for trt 4. Mixing time was shorter ($P < 0.05$) for precut than for conventional bales, regardless of bale size (72 vs. 142 s for 1.5 × 1.2 m and 110 vs. 237 s for 1.8 × 1.2 m, respectively). Fuel usage for the 1.5 × 1.2 m precut bales was lower ($P < 0.05$) than the 1.5 × 1.2 m conventional bales (7.48 vs. 8.00 L/h), but similar for 1.8 × 1.2 m bales (9.23 vs. 9.14 L/h). Fuel usage per bale was lower ($P < 0.001$) for precut than for conventional regardless of size (0.15 vs. 0.31 L/bale for 1.5 × 1.2 m and 0.28 vs. 0.60 L/bale for 1.8 × 1.2 m). In Exp. 2, one field of cornstalks was swathed, brush hogged, or flail shredded and baled; treatments were: 1) conventionally baled brush hog, 2) precut baled brush hog, 3) conventionally baled flail shredded, 4) precut baled flail shredded, 5) conventionally baled swathed, and 6) precut baled swathed. All bales were 1.5 × 1.2 m. There were 8 replicates for trts 1, 2, 3, 5, 6 with 7 replicates for trt 4. Mixing time for precut bales decreased ($P < 0.001$; 39.8 s vs. 77.9 s) compared to conventional bales. Flail shredded bale mixing time was less ($P < 0.02$; 39.9 and 64.6 vs. 39.6 and 83.5 s for precut and conventional bales, respectively) than for swathed bales. Fuel usage for precut bales (0.12 L/bale) was lower ($P < 0.01$) than for conventional bales (0.23 L/bale). The precut method of baling forage decreased bale breakup time and fuel usage per bale.

Key Words: alfalfa, cornstalk, mixer

307 Effect of advancing fermentation on cell wall monosaccharide composition of by-product feeds. S. J. Harris* and M. S. Kerley, *University of Missouri, Columbia.*

Price volatility of corn has fueled interests in identifying alternative energy sources for feedlot cattle. Fibrous by-product feeds offer an alternative due to their availability. Competitive use of by-product feeds in feedlot applications requires energy values more similar to corn. We hypothesized that differences in energy value between by-products and corn were due to polysaccharide degradation rate. An additional objective was to determine if specific monosaccharides increased as fermentation time proceeded, indicating glycosidic bonds or fiber fractions more resilient to microbial hydrolysis. Degradation rate of NDF was measured in vitro for five by-product feeds [corn bran (CB), corn gluten feed, dried distillers grains, soy hulls, and wheat middlings (WM)]. These feeds represent materials skewed with high hemicellulose and high cellulose concentration. Degradation rate of degradable NDF (k_{NDF}) averaged 2.3 %/h, with no difference ($P \geq 0.05$) in k_{NDF} among by-product feeds. Starch degradation rate (k_{starch}), measured in by-product feeds and corn starch averaged 5.0 %/h with no difference ($P \geq 0.05$) among substrates. When k_{NDF} and k_{starch} were placed into first order kinetic models (6%/h passage rate), predicted ruminal digestibility of by-product feeds averaged 72% of corn. We concluded that rate of polysaccharide degradation was the primary factor limiting energy equivalency of by-product feeds to corn. Cell wall sugars were analyzed at various time points of fermentation. Glucose proportion increased ($P \leq 0.05$) over time in all feeds except CB (high hemicelluloses). Xylose proportion increased ($P \leq 0.05$) over time in CB. Proportion of minor cell wall sugars generally tended to decrease over fermentation time. We concluded that glucose and xylose increased because hydrolysis rate of major polysaccharides was the primary determinant of k_{NDF} rather than steric hindrance of enzymes by minor cell wall sugar linkages.

Key Words: by-product feeds, cattle, cell wall

308 Effect of milk-based by-products on forage in vitro fermentation. M. H. Ramos* and M. S. Kerley, *University of Missouri, Columbia.*

We studied the effect of milk-based by-products containing lactose and sucrose on alfalfa and tall fescue hay fermentation parameters using in vitro and single flow continuous culture procedures. Five levels of alfalfa (ALF) or tall fescue (0, 10, 20, 50 and 75% of DM) were combined with butter milk (BM), ice-cream by-product (ICBP) or ice-cream by-product with cone (ICBPWC). By-products were added to specific forages to make 100% DM. Dry matter digestibility increased for ALF and tall fescue as by-product level increased, with a higher DMD increase occurring for fescue than ALF. Continuous culture fermentation used only ALF as a forage source, and BM and ICBPWC were the only by-products used. Levels of by-products were: 0, 50 and 100% of DM. BM treatment increased DMD and organic matter digestibility linearly ($P < 0.05$) while addition of ICBPWC resulted in a linear increase of NDF digestibility. Addition of by-product did not produce a change in total VFA production, while pH decreased linearly for ICBPWC and ammonia increased linearly for both treatments. Microbial efficiency was not different among treatments. Addition of milk-based by-products was not detrimental to forage NDF digestibility and increased DMD of the total diet.

Key Words: by-products, continuous culture, forage

309 A meta analysis comparing nitrogen fertilization versus interseeded legume on performance of ruminants. M. H. Ramos*¹ and J. W. Lehmkuhler², ¹*University of Missouri, Columbia,* ²*University of Kentucky, Lexington.*

A meta-analysis was conducted to examine animal response to legume incorporation into pastures compared to nitrogen fertilization. A total of 50 papers were included in the analyses which met the criteria of having valid comparative data for legumes and nitrogen application. PROC MIXED (SAS Institute) was used with year of experiment as a block and use of nitrogen or legume as the treatment. A difference ($P = 0.059$) in DM intake was found for stocker cattle in which cattle grazing pastures with interseeded legumes had higher intakes (7.2 kg vs. 6.7 kg, respectively) than those grazing nitrogen fertilized pastures. The amount of beef produced per hectare did not differ ($P > 0.05$) between treatments (556 vs. 617 kg/hectare, for legume and nitrogen respectively). Nitrogen fertility supported more lambs per hectare ($P < 0.05$) than legume (28 vs. 22 hd, respectively) and greater ($P < 0.05$) daily gains (331 vs. 241 g/day, respectively). Nitrogen fertility supported a higher ($P < 0.05$) carrying capacity for dairy cows than legume. Daily milk production was greater ($P < 0.05$) for legume compared to Nitrogen (20 vs. 18 kg/d, respectively). Regardless of species, grazing pastures containing a proportion of legumes had similar or improved performance and production per land unit when compared to pastures fertilized with nitrogen even though nitrogen fertilizer increased forage productivity supporting more animals per land unit.

Key Words: nitrogen, legume, grazing

310 (Dairy Innovation Award) Intestinal digestibility of amino acids in rumen undegraded corn silage using the mobile bag technique. S. M. Fredin*¹, H. Lapierre², N. L. Whitehouse¹, and C. G. Schwab¹, ¹*University of New Hampshire, Durham,* ²*Agriculture and Agri-Food, Sherbrooke, QC, Canada.*

A study was conducted to measure intestinal and total tract digestibility of crude protein (CP) and amino acids (AA) in rumen undegradable protein in five corn silage (CS) hybrids using the mobile bag technique. For each CS sample, ten bags were incubated in situ in two ruminally-cannulated lactating dairy cows fed a diet consisting of 50% forage and 50% concentrate, for either 16 or 24 h. Profile of AA in rumen undegraded residue (RUR) was consistent between CS samples for both incubation periods. The proportion of essential AA in total AA increased in RUR compared to intact CS. Six bags per RUR were inserted through duodenal cannulas of the same two cows used for the in situ incubation and recovered in the feces. Intestinal digestibility of AA in RUR varied from 24 to 59%, indicating differences in intestinal digestibility among AA. Digestibility values were lowest for Cys and Gly and highest for Arg, Met, and Glu. Intestinal digestibility of total AA ranged from 36 to 62% whereas intestinal digestibility of CP varied from 18 to 43%. This suggests that non-protein-N is less digestible than AA, and probably bound to indigestible components within RUR. The large range in intestinal digestibility of AA was not apparent in the total tract digestibility of AA, which ranged from 78 to 89%. There was no difference ($P > 0.05$) between intestinal digestibility of AA for RUR ruminally incubated at 16 or 24 h, indicating that a 16-h rumen incubation is sufficient to determine digestibility of AA in the RUR of CS. Digestibility of AA in RUR reported here indicates that NRC (2001) tabular values for CP in CS, equal to 70%, may be overestimated.

Key Words: amino acid digestibility, corn silage, mobile bag technique

311 Performance of post-weaned Holstein heifer calves fed grain mixes supplemented with essential oils at differing levels.

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Ninety-six dairy heifers (86.7 ± 0.43 kg BW) were randomly allocated to 1 of 4 treatments to evaluate the effect of essential oils on feed intake and performance from 9 to 25 weeks of age. Heifers were housed in 9.14 × 4.57 m pens (6 heifers/pen) within a naturally ventilated bedded-pack pole barn with 4 replicated pens/treatment. Treatments were 1) control (CON); 2) 100 mg per head/day of Rumaxol, a combination of oregano, chyme, cinnamon, and citric fruit extracts (R100); 3) 200 mg per head/day of Rumaxol (R200); 4) 400 mg per head/day of Rumaxol (R400). All treatment grain mixes were fed at 2.08 kg/head/d and formulated to contain 18.0% CP (DM basis) and decoquinatate at recommended levels. Heifers had access to a 17% CP hay (123.2 RFV) free choice for the duration of the trial. Data were analyzed as repeated measures using the PROC MIXED procedure of SAS and contrasts were used to compare treatment affects. Over the 112 d study period there were no significant differences between treatments. Under the conditions of this study the addition of essential oils (Rumaxol) was not effective in improving the intake or performance of post-weaned heifer calves. Performance of all heifers was very acceptable.

Table 1. Performance of post-weaned Holstein heifer calves fed grain mixes supplemented with essential oils at differing levels.

Item	CON	R100	R200	R400	SEM
Day 1 to 112					
ADG, kg/d	0.97	0.97	0.96	0.96	0.02
Grain DMI, kg/d	2.07	2.07	2.07	2.09	0.002
Hay DMI, kg/d	2.38	2.38	2.29	2.23	0.07
Total DMI, kg/d	4.44	4.44	4.38	4.31	0.07
Feed/gain, kg	2.07	2.08	2.08	2.04	0.04
Hip height gain, cm	21.0	20.0	20.4	20.4	0.58

^{a,b}Means within a row without common superscripts are different at $P < 0.05$.

Key Words: dairy heifers, essential oils, performance

312 Partial replacement of corn silage and alfalfa with Italian ryegrass silage in lactating cow diets. J. Woolever* and D. K. Combs, University of Wisconsin, Madison.

Our objective was to assess the effectiveness of a high quality Italian ryegrass silage as a source of digestible fiber in dairy cattle diets. Forty-eight Holstein and Jersey x Holstein cows between 30 and 90 DIM were randomly assigned to six pens (8 per pen). One of two diets were randomly allocated to each pen in a cross-over design with two-21 day periods. At the end of the first period, diets were switched so that cows within each pen were fed each diet. The pens were sand bedded free stalls with one stall per cow and bunk space to allow all cows to eat at one time. Cows had access to feed and water at all times. Diets were fed once daily, and amount fed was adjusted daily to allow approximately 5% refusals. Treatments were a diet (CONTROL) formulated with corn silage (25% of diet DM) and alfalfa silage (25% of diet DM) and a test diet (RYE) formulated with 35% of the corn silage (17% of diet DM) and alfalfa silage (17%

of diet DM) replaced by high quality Italian ryegrass silage (17% of diet DM). The remainder of both diets contained high moisture shelled corn (29.5% of diet DM) soybean meal, distillers grains, corn gluten feed, minerals and vitamins. Replacement of corn silage and alfalfa with ryegrass shifted the diets to provide more fermentable fiber (26.9% NDF, 60.6% NDF vs 24.8% NDF, 50.2% NDF for RYE and CONTROL, respectively) and less NFC (46% vs 48% NFC, for RYE and CONTROL, respectively). Milk yield did not differ by CONTROL or RYE diet (7,196 kg vs. 7,003 kg milk per treatment pen, respectively; $P > 0.40$). Milk fat test was higher from pens of cows fed RYE than CONTROL diets (3.75% vs. 3.60%; $P < 0.05$). Fat corrected milk production was similar for CONTROL and RYE diets (7,321 kg vs. 7,301 kg). Milk protein levels and yield, lactose, or SCC did not differ due to treatment. Cows fed the diet including ryegrass silage produced similar levels of milk and fat corrected milk compared to the more traditional high NFC diet containing high levels of corn and alfalfa silages. Including grass appears to be a feasible strategy to reduce the NFC level of lactation diets and increase digestible fiber without reducing milk yield.

Key Words: dairy, forage, silage

313 Pro-vitamin A carotenoids in feedstuffs. C. L. Pickworth^{*1}, S. C. Loerch¹, F. L. Fluharty¹, R. E. Kopec², and S. J. Schwartz², ¹The Ohio State University, Wooster, ²The Ohio State University, Columbus.

High dietary concentrations of vitamin A may limit adipogenesis in cattle, therefore reducing carcass quality and value. There is limited information available on the pro-vitamin A carotenoids in feedstuffs commonly fed to beef cattle. Therefore, the objective of this study was to determine the pro-vitamin A carotenoid concentration of 18 feedstuffs. The pro-vitamin A carotenoids determined were β - and α -carotene, and β -cryptoxanthin. This study involved the collaboration of five states for feedstuff sample collection. Carotenoids were extracted with hexane from the feedstuffs and then quantified using high pressure liquid chromatography-photodiode array (HPLC-PDA) analysis. Proc MEANS was used to calculate a mean and standard error for each feedstuff. Fresh pasture had the highest vitamin A equivalents and greatly exceeded hay and corn silage (39,865 ± 2,646, 2,982 ± 809, and 7,299 ± 805 IU/kg DM for pasture, hay and corn silage, respectively). Roughages had negligible amounts of β -cryptoxanthin and α -carotene. Vitamin A equivalents in roughages decreased with increasing storage periods. Only corn-based feedstuffs had appreciable concentrations of all three pro-vitamin A carotenoids quantified. Post-harvest corn processing had minimal impact on the carotenoids. High moisture corn contained 54% more vitamin A equivalents than whole shelled corn (378 ± 38 and 174 ± 19 IU/kg of DM, respectively). Pro-vitamin A carotenoids were more concentrated in corn co-products than whole shelled corn, and corn gluten meal had the highest concentration (3,747 IU/kg of DM). The pro-vitamin A carotenoids may have been degraded by drying distillers grains with solubles (800 ± 62 and 482 ± 83 IU/kg of DM for wet and dry distillers grains, respectively). Soybean meal and soyhulls contained only 55 ± 10 and 45 ± 7 IU of vitamin A equivalents/kg of DM, respectively. Overall, there was considerable variation in the pro-vitamin A content of feedstuffs based on sampling location and storage conditions. A more extensive analysis and characterization of feedstuffs would need to be conducted to accurately estimate the vitamin A potential of feedlot cattle diets.

Key Words: vitamin A, carotenoids, feedstuffs

314 Effect of housing on sustainability of beef cattle production.

H. Koknaroglu¹ and M. P. Hoffman*², ¹*Suleyman Demirel University, Isparta, Turkey*, ²*Iowa State University, Ames.*

A summer feeding trial involving 188 yearling steers of predominantly Angus and Hereford breeds, with mean body weight of 299 kg which started on 28 April and finished on 3 October and a winter feeding trial involving 182 yearling steers of predominantly Angus and Hereford breeds, with mean body weight of 327 kg which started on 8 November and finished on 12 April were used to assess the effect of housing on cultural energy analysis of beef cattle production systems. Housing used in this study consisted of three outside lots with access to overhead shelter, three outside lots with no overhead shelter and a semi-enclosed (open-front) cold confinement building containing four lots. Open lots and open lots with access to an overhead shelter treatments had 18 and 17 steers per pen, in summer and winter trials, respectively, and confinement treatment had 20 steers per pen. Ad libitum corn, 2.27 kg of 35% dry matter whole plant sorghum silage and 0.68 kg of a 61% protein-vitamin-mineral supplement was offered. Cultural energy used for feed for lots was derived from their corresponding lot feed consumption and their corresponding values from literature. Transportation energy was also included in the analysis. In terms of total cultural energy expended, each housing differed from each other and it was highest for shelter and was lowest for confinement ($P < 0.05$). Feed energy constituted more than half of the total cultural energy and was highest for shelter and lowest for confinement ($P < 0.05$). Cattle fed in shelter had lower energy expended per kg live weight ($P < 0.05$). Cattle fed in open lot had higher energy expended per kg carcass ($P < 0.05$). Cultural energy per Mcal protein energy was highest for open lot and it differed from shelter and confinement ($P < 0.05$). The energy output ratio defined as the Mcal input/Mcal output was better for shelter and was poorest for open lot ($P < 0.05$) and confinement was intermediate, thus not differing from other groups ($P > 0.05$). Results show that housing provided affects energy input/output ratio in beef cattle production. Shelter housing providing more comfortable environment increases sustainability of beef cattle production.

Key Words: cultural energy, housing, sustainability

315 Season affects energy input/output ratio in beef cattle production.

H. Koknaroglu¹ and M. P. Hoffman*², ¹*Suleyman Demirel University, Isparta, Turkey*, ²*Iowa State University, Ames.*

A summer feeding trial involving 188 yearling steers of predominantly Angus and Hereford breeds, with mean body weight of 299 kg, which started on 28 April and finished on 3 October, and a winter feeding trial involving 182 yearling steers of predominantly Angus and Hereford breeds, with mean body weight of 327 kg, which started on 8 November and finished on 12 April, were used to assess the effect of season on cultural energy analysis of beef cattle production systems. In each season, housing consisted of three outside lots with access to overhead shelter, three outside lots with no overhead shelter and a semi-enclosed (open-front) cold confinement building containing four lots. Ad libitum corn, 2.27 kg of 35% dry matter whole plant sorghum silage and 0.68 kg of a 61% protein-vitamin-mineral supplement was offered. Cultural energy used for feed for lots was derived from their corresponding lot feed consumption and their corresponding values from literature. Transportation energy was also included in the analysis. Cattle fed in summer had higher total cultural energy expenditure than those fed in winter ($P < 0.05$). Feed energy constituted more than half of the

total cultural energy and was higher for summer fed cattle ($P < 0.05$). Energy inputs/kg live weight and/kg carcass were lower for summer fed cattle ($P < 0.05$). Cultural energy per Mcal protein energy was higher for winter fed cattle ($P < 0.05$). The energy output ratio defined as the Mcal input/Mcal output was better for summer fed cattle ($P < 0.05$). Results show that time of feeding affects cattle performance and cultural energy use and summer feeding is an effective way of increasing sustainability of beef cattle production.

Key Words: season, energy input-output, sustainability

316 The effect of LAB on in vitro ruminal fermentation.

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The effect of a proprietary lactobacillus fermentation product (LACT) on microbial growth and diet digestibility was measured using continuous culture fermenters. Twenty four single phase fermenters (six per treatment) were fed a diet (46.25% corn, 46.25% soyhulls, and 7.5% soybean meal) twice daily (30 g per feeding) for seven days. Treatment was level of LACT (0%, 0.01%, 0.04% and 0.08%) in diet. McDougall's artificial saliva-high buffer was used at a dilution rate of 6.0% per hour. Fermenter samples were taken four hours after morning feeding for the last three days of the experiment. Effluent was composited over the last three days. Fermenter and effluent samples were measured for pH, VFA and ammonia concentration and optical density. Effluent samples were lyophilized and analyzed for purine and organic matter concentration to calculate microbial efficiency. A trend for improved microbial efficiency occurred for the 0.01% treatment. Treatments 0.04 and 0.08% decreased organic matter digestibility (linear; 0.04). Ammonia concentration decreased (quadratic; 0.06) for 0.01 and 0.04% treatments. These data and the trend for improved microbial efficiency for 0.01% treatment were corroborated by the numerically greater microbial protein flow for the 0.01% treatment. Treatments with LACT compared to the 0% treatment promoted greater propionic acid (linear; 0.09) and total VFA concentrations (linear; 0.02). We concluded that LACT fed at optimum level improved microbial growth and VFA yield in rumen fermentation. Ruminal effects measured in this experiment could explain growth performance benefits reported in cattle fed diets with LACT. The most efficacious LACT dose was between 0.01 and 0.04% of diet.

Key Words: ruminal fermentation, lactobacillus, beef

317 Comparing feed efficiency of F1 heifers from dams and sires phenotyped for residual feed intake (RFI).

N. O. Minton*, R. Kallenbach, M. S. Kerley, and R. L. Weaber, *University of Missouri, Columbia.*

The intent of this study was to determine the effect on feed efficiency of progeny produced from a mating of RFI phenotyped cows and sires. We hypothesize divergent selection for RFI would produce progeny that separated themselves based upon efficiency of feed use for maintenance and growth. Simmental crossbred heifers (n=16 RFI- and n=18 RFI+) were mated with RFI- (n=2) bulls and RFI+ (n=2) bulls. Three dam groups were formed by assigning heifers as follows, one SD greater than (INEFF) and one SD less than (EFF) average (AVG) RFI. Sire was used as an independent variable to measure effect of sire on progeny performance. Heifer progeny were placed on feed

post weaning and intake and BW were measured over 70d. Intake and weight data were used to calculate ADG, intake, feed conversion ratio (FCR) and RFI. Divergent selection for RFI resulted in no significant difference ($P \geq 0.10$) in ADG among dam RFI group or sire. Progeny from INEFF dams had greater FCR ($P \leq 0.09$) than progeny from EFF or AVG dams (6.35, 5.60, and 5.57, respectively). Intakes differed numerically but not significantly ($P \geq 0.10$). When dams were grouped as RFI- and RFI+ no significant difference was measured in ADG of progeny, but progeny from RFI- dams had decreased intake (9.41 v 10.46; $P \leq 0.05$), lower RFI (-0.42 v 0.38; $P \leq 0.05$), and an improved FCR (5.51 v 6.04; $P \leq 0.10$). Progeny performance differed among sires. Unexpectedly, one RFI+ sire produced progeny with similar RFI and FCR performance as progeny from RFI- sires. Progeny from different sires did not differ in ADG ($P \geq 0.10$). Progeny performance from three sire groups was similar and better than one RFI+ sire used (intake, FCR and RFI were 9.54 v 10.9, 5.62 v 6.47, and -0.39 v 0.68, respectively, for average of three sires v RFI+ sire; $P \leq 0.05$). Using RFI- sires while selecting against INEFF dams improved progeny FCR by 14%. Similarly, sire selection influenced FCR, with progeny group extremes improving FCR by 15%. We concluded that RFI selection could improve progeny FCR.

Key Words: residual feed intake, feed efficiency, beef selection

318 Feeding MSE direct-fed microbials to finishing cattle decreases the fecal shedding of *Escherichia coli* O157:H7. M. E. Jacob*¹, K. Lechtenberg², L. L. Burnham³, D. Haverkamp³, and T. G. Nagaraja¹, ¹Kansas State University, Manhattan, ²Midwest Veterinary Services, Oakland, NE, ³Nature's Way, Inc., Horton, KS.

Escherichia coli O157:H7, a foodborne pathogen, continues to be a major public health concern. Cattle are the primary reservoir; the organisms reside in the hindgut and once shed can contaminate food and water. Intervention strategies at harvest reduce the risk of the pathogen entering the food chain, however, pre-harvest intervention strategies reduce the *E. coli* O157:H7 burden prior to cattle entering the processing plant. Direct-fed microbials (DFM) appear to be a promising pre-harvest intervention strategy. In this study, we evaluated the effect of a commercially available DFM product on *E. coli* O157:H7 prevalence in feedlot cattle fed for fifteen days prior to harvest. The DFM product, MSE Microbial Concentrate (Nature's Way, Inc.), contains *Lactobacillus acidophilus*, *L. casei*, *Saccharomyces cerevisiae*, *Enterococcus faecium*, and a fungal extract. Ninety-six cattle, previously screened and shown to be fecal positive for *E. coli* O157:H7, were randomly assigned to one of sixteen pens (6 cattle/pen). Eight pens of cattle were fed a corn grain-based (control) diet while cattle in eight treatment pens were given the control diet plus a daily top-dressed dose (0.5 g/Kg of feed) of DFM. Fecal grab samples were obtained from each animal on d 0, 7, and 15 and cultured for *E. coli* O157:H7. In addition, a semi-quantification technique was used to determine the number of super shedders on d 15. On d 0, both control and DFM groups had an *E. coli* O157:H7 prevalence of 22.9%. Across sampling days, the average fecal prevalence of *E. coli* O157:H7 in control cattle (22.2%) was higher ($P < 0.05$) than cattle fed the DFM (10.3%). The prevalence of *E. coli* O157:H7 was reduced by 54% and 80% on d 7 and 14, respectively, in the DFM group compared to the control. On d 15, 3 cattle in the control group and none in the DFM treatment group were super shedders. The results indicate that the MSE DFM product may be a useful pre-harvest intervention tool to reduce *E. coli* O157:H7 prevalence in finishing cattle.

Key Words: cattle, *E. coli* O157:H7, direct-fed microbials

319 Evaluation of intake prediction by the Cornell Value Discovery System model (CVDS), effective energy (EE) and net energy equations (NE). Y. Liang*, J. Sexten, and M. S. Kerley, University of Missouri, Columbia.

Individual intake was measured for 70 days or longer in two groups (80 head per group) of finishing steers fed corn-based diets and compared to intake predicted by three models (CVDS, group one only; EE and NE). Intake predicted by CVDS and EE in group one had significant mean bias ($P \leq 0.05$), but no significant mean bias ($P \geq 0.05$) occurred for NE. However, mean bias in group two was significant for NE but not for EE. The CVDS model explained 55-60% of variation in observed DMI for group one, with an average over prediction of 13%. EE equation accounted for 72% of variation in observed DMI for group one and 62% for group two steers. NE equations based either on initial body weight and dietary NEm concentration (without or with ionophore adjustment) were no different and accounted for 50% of intake variation (table). We concluded equations adjusted for growth are superior to equations using diet NE value and body weight. EE equations had better fit than NE equations, presumably due to more accurate prediction of energy expenditure for lean and fat growth by the animal. Correlation coefficients were improved to 0.91 or greater when residual feed intake (RFI) and to greater than 0.99 when RFI and average daily gain were used as independent variables in multiple regression models. If RFI is defined as metabolic efficiency, 99% of intake variation can be explained by energy predicted for maintenance and growth, and individual animal differences in metabolic efficiency and daily gain.

Table 1.

Item	CVDS		EE		NE		
	Carcass model	HCW & Yield Grade Model	65kcal MH*	77kcal MH*	Initial BW	NE _m -based	NE _m -based mon-ensin-adjusted
Group 1							
Mean Bias, kg	-0.97	-1.38	1.02	0.62	0.45	-0.32	0.40
P<	≤0.01	≤0.01	≤0.01	≤0.01	≤0.01	0.15	0.66
R ²	0.60	0.55	0.72	0.73	0.48	0.56	0.56
R ² (RFI,ADG)	-	-	0.9978	0.9980	0.9840	0.9654	0.9677
Group 2							
Mean Bias, kg	-	-	0.34	-0.04	-0.88	-1.57	0.71
P<	-	-	0.05	0.82	≤0.01	≤0.01	≤0.01
R ²	-	-	0.62	0.62	0.49	0.52	0.52
R ² (RFI,ADG)	-	-	0.9976	0.9978	0.9998	0.9739	0.9761

*65 and 77 kcal per kg empty BW maintenance heat production in EE equation

Key Words: CVDS, effective energy, intake prediction equations

320 Feeding dried or wet distillers grains at varying inclusion levels to feedlot cattle affects the fecal prevalence of *Escherichia coli* O157:H7. M. E. Jacob*¹, D. G. Renter¹, Z. D. Paddock¹, K. Lechtenberg², and T. G. Nagaraja¹, ¹Kansas State University, Manhattan, ²Midwest Veterinary Services, Oakland, NE.

Feeding distillers grains (DG) to feedlot cattle has been shown to increase fecal prevalence of *E. coli* O157:H7, a major foodborne pathogen. Previous studies have evaluated prevalence in cattle fed

diets with or without dried (DDG) or wet DG (WDG), however, none of the studies directly compared DDG and WDG. The objective of this study was to evaluate the fecal prevalence of *E. coli* O157:H7 in feedlot cattle fed 0, 20 or 40% DDG or WDG. Eight hundred forty steers were randomly allocated to one of seventy pens (12 head/pen) in a commercial feedlot. Treatments, 0% DG (control), 20% DDG or WDG, and 40% DDG or WDG, were randomly allocated within a block of five pens; each treatment was replicated in 14 pens. Eight pen floor fecal samples were collected from each pen every two weeks for twelve weeks (6 collections) for isolation of *E. coli* O157:H7. In addition, all samples were evaluated by direct plating to identify cattle that were super-shedders. The overall prevalence of *E. coli* O157:H7 was 21.2% with 3.2% of samples classified as super shedders. The inclusion of DG increased ($P = 0.07$) the prevalence of *E. coli* O157:H7 compared to the control cattle. The type of DG, DDG or WDG, did not impact prevalence; however, inclusion level was significantly associated with the prevalence of *E. coli* O157:H7. Prevalence was not different between cattle fed diets with 0 or 20% DG, however, cattle fed 40% DG had significantly higher prevalence than either 0 or 20% DG ($P = 0.02$). Similarly, the prevalence of super shedders was not different between cattle fed diets with WDG or DDG; however, inclusion level was associated with prevalence. Prevalence of super shedders in cattle fed 0 or 20% DG were not different, however, cattle fed 40% DG diets had a higher prevalence of high shedders than cattle fed either 0 or 20% DG ($P = 0.03$). Results from this study confirm the positive association between fecal *E. coli* O157:H7 and feeding of DG in feedlot cattle. In addition, the inclusion level (20 vs. 40%) but not the type of DG (DDG or WDG) was associated with fecal prevalence of *E. coli* O157:H7.

Key Words: cattle, *E. coli* O157:H7, distillers grains

321 Effects of a *Bacillus*-based direct-fed microbial on calf performance. C. A. Wehnes^{*1}, A. H. Smith¹, T. G. Rehberger¹, and D. Shields², ¹Danisco USA, Inc., Waukesha, WI, ²Merrick's, Inc., Union Center, WI.

A *Bacillus*-based direct-fed microbial (DFM) product previously improved calf performance when fed therapeutically in response to dehydration. The present study evaluated the effects of two prophylactic modes of delivering this DFM to calves. The objectives of this study were to quantify the effects of the DFM, as a bolus or incorporated into a 20% protein 20% fat calf milk replacer (CMR), on calf performance compared to unsupplemented calves. Holstein bull calves (72) were placed in outdoor hutches. Calves were randomly assigned to three treatments: control, bolus (9×10^9 cfu/bolus), and CMR (2×10^9 cfu/head/day). Bolus treated calves received two boluses: one bolus on d 0 and d 6. Calves were weaned on d 43 if they had consumed 1 lb starter feed for three consecutive days. The *Bacillus* DFM increased ($P = 0.03$) ADG during wks 3-6 in both bolus and CMR treated calves compared to control calves. The *Bacillus* DFM increased ($P = 0.05$) G:F during wks 0-6 in both bolus and CMR treated calves compared to control calves. However, differences in DFM delivery were noted in G:F during wks 3-6 as the CMR treatment resulted in increased ($P = 0.05$) G:F compared to control calves with bolus treated calves showing an intermediate response. Another difference between the DFM deliveries was that calves treated with the bolus gained more ($P = 0.05$) weight in wk 3 than CMR treated calves with control calves showing an intermediate response. Conversely, during wk 6, CMR treated calves gained more ($P = 0.01$) weight than both bolus treated and control calves. The *Bacillus* DFM improved ($P = 0.09$) fecal scores in wk 5 in

both bolus and CMR treated calves compared to control calves. Some of the improvements witnessed in the *Bacillus* treatments on feed efficiency during wk 0-6 were countered by a reduction ($P = 0.01$) in G:F during wks 6-8 in DFM treated calves compared to control calves so that the total feed efficiency for wks 0-8 was not significant ($P = 0.98$). The results indicate that the *Bacillus* DFM improved calf performance as evidenced by improved ADG, fecal score, and feed efficiency.

Key Words: probiotic, DFM, bovine

322 Influence of supplemental calcium and feeding fish oil on growth performance and fatty acid composition of muscle of grazing calves. J. T. Richeson^{*1}, E. B. Kegley¹, and T. J. Wistuba², ¹University of Arkansas, Division of Agriculture, Fayetteville, ²Morehead State University, Morehead, KY.

To determine the effects of supplemental Ca on the absorption of long chain fatty acids (FA) from fish oil fed to growing cattle, crossbred beef calves ($n = 64$, initial BW = 249 ± 3 kg) were stratified by source, previous vaccination treatment, and sex then assigned randomly to 16 pens. Pens were assigned randomly to receive 1 of 4 supplements: 2 levels of fish oil (0 or 2%) and 2 levels of Ca (0.5 or 2%) in a 2×2 factorial arrangement of treatments. Data were analyzed using the GLM procedure of SAS with pen as the experimental unit and preplanned contrasts were the main effects of fish oil and Ca, and their interaction. Calves grazed mixed-grass pastures during the 84-d study and were offered 1.8 kg/d of the appropriate grain supplement. Muscle biopsies were obtained at the conclusion of the trial to determine differences in FA composition. Calves receiving fish oil tended ($P = 0.10$) to weigh less on d 28, but there were no other performance differences ($P \geq 0.15$) observed. There were effects of fish oil supplementation observed for palmitic acid (C16; $P = 0.001$), palmitelaidic acid (C16:1*trans*9; $P < 0.01$), C18:1*trans* FA ($P < 0.001$), 11-octadecenoic acid (C18:1*cis*11; $P = 0.01$), arachidic acid (C20; $P = 0.03$), eicosenoic acid (C20:1*cis*11; $P = 0.01$), octadecadienoic acid (CLA*trans*10,*cis*12; $P < 0.001$), and total *trans* FA ($P < 0.001$). Concentrations (g/100 g total FA) of these FA in the muscle were all greater in fish oil supplemented calves. Furthermore, an effect of Ca level ($P = 0.02$) and a tendency for a Ca \times fish oil interaction ($P = 0.08$) were observed for C16 with the greatest concentration of C16 found in the cattle fed fish oil with low Ca. Results suggest that dietary fish oil supplementation of grazing calves may increase several muscle FA concentrations with minimal impact on cattle performance; however, dietary Ca concentrations had little impact on muscle FA composition.

Key Words: fatty acid, beef cattle, fish oil

323 Nutrient concentration as affected by supplement form (liquid vs dry) in a high moisture finishing ration. J. P. Jaderborg^{*1}, G. I. Crawford³, C. Lahr², H. Blalock², and A. DiCostanzo¹, ¹University of Minnesota, St. Paul, ²Quality Liquid Feeds, Dodgeville, WI, ³Regional Extension Office, Hutchinson, MN.

We conducted a randomized block design study with repeated measures in time and in location to determine effects of supplement form (dry vs liquid) on consistency and variability in total mixed ration (TMR) nutrient concentration. Feedlot TMR batches were mixed using (loading order; % as-fed) 22.6% or 22.7% corn silage, 2.8% or 3.0% hay, 53.5% or 53.4% 52%-moisture distillers grains and solubles, 19.3% dry rolled corn, and either a 1.7% pelletized (DRY) or 1.9%

liquid (LIQ) supplement. Batch totals were based on ration totals determined from bunk scores (0, slick bunk, to 4, crown untouched) for each of two bunks (pens) per supplement form for four consecutive days. Each batch was delivered first to a short (7 m; 15 or 17 head) and then to a long (18.3 m; 51 or 56 head) concrete bunk. Using a sub-sample of TMR ingredients, standard DRY and LIQ batches were made in a Hobart mixer with a flat beater attachment. Concurrently, DRY and LIQ rations were mixed in a 4-auger mixer. Bunk samples were collected in each of three locations within the bunk. Samples were collected at time 0, 1, 3, and 6 h post-delivery. Samples were analyzed for CP, ADF, Ca and Zn concentration. Standard batches were similar ($P > 0.05$) in CP and ADF across supplement form for, but were greater ($P < 0.03$) for DRY Ca and Zn content. Similar results were obtained

from analyses of TMR samples, but TMR nutrient content SE were greater, and Ca and Zn concentration tended ($P < 0.10$) to be lower for DRY. Samples collected from the long bunk for DRY TMR tended ($P < 0.10$) to be lower in CP than those from the short bunk. Concentration of ADF in the three sample sites from the short bunk were lower ($P < 0.05$) for LIQ TMR ADF than that in the first and last sample location from the long bunk. Pooled within-bunk variance was numerically ($P = 0.15$) greater for DRY TMR Zn concentrations, and significantly ($P = 0.02$) greater for DRY TMR ADF concentrations. Batches prepared with LIQ appeared to be more consistent across bunks and within bunks, albeit off target for CP and ADF, and less variable for ADF.

Key Words: mixing, dry supplement, liquid supplement

Teaching

324 (Invited) New directions in agricultural education. D. L. Boggs*, *Kansas State University, Manhattan.*

Changes in the agricultural industries, in skills of incoming agricultural students, and in the way society views agriculture require constant review and reconsideration of learning outcomes and the agriculture curriculum. Animal science programs have adapted from a discipline and husbandry base to incorporate business, technology and bioscience components into their curricula and student outcomes. But they must continue to refine and redesign curricula to keep students prepared for the industry issues ahead. The National Academy of Science (NAS) recently released the proceedings of the Leadership Summit to Effect Change in Teaching and Learning. At the Summit, agricultural industry representatives expressed a need for students to receive more training in workplace and life skills. Additionally, agriculturalists are receiving more scrutiny from society in general and are often placed in a defensive mode regarding management and husbandry. Students must be able to participate in civil discourse regarding agricultural issues. In the NAS report, recommendations are made to academic institutions, including the need to "broaden the undergraduate experience to integrate opportunities to develop transferable skills, including communication, teamwork, and management; participate in undergraduate research; participate in outreach and extension; participate in internships that provide experiences beyond the classroom; and provide exposure to international perspectives". These issues are further complicated by a decreasing number of prospective students who are familiar with agricultural practices or the career opportunities available in agriculture and its related industries. This has led the Agriculture Academic Programs Section of the APLU to develop a white paper on "Human Capacity Development". This publication addresses the need to attract new students to agriculture; renew the academy to prepare future faculty to advance frontiers in learning, discovery and engagement; and evolve agricultural education. It is imperative that colleges of agriculture and departments of animal science act now to ensure the successful preparation of students for careers in an ever-changing industry.

Key Words: curriculum, issues, learning outcomes

325 (Invited) Creating industry advocates in the classroom: Media interview project. J. A. Sterle*, *Texas A&M University, College Station.*

As demographics of Animal Science students shift away from those with an agricultural background to students without such association, attitudes toward management practices and basic understanding of issues facing the livestock industry have also changed. Instructors now need to include more reasoning behind principles and practices in their courses. The past three fall semesters, students enrolled in Honors ANSC 107-General Animal Science completed a media interview project. Pairs of students drew 1 of 11 current issue topics mid-semester. Groups wrote a term paper on the background and science of the issue, including opposing viewpoints. Pairs were later given a scenario specific to their topic designed to create a real-life situation which required students to defend their issue under a somewhat hostile environment. A modified version of Operation Main Street (National Pork Board) trained students to develop message points and control a media interview. Students were interviewed on camera by a seasoned reporter familiar with the livestock industry. Class size was 21, 18, and 32 in fall semesters 2006-08. Students evaluated the project on a 1-5 Likert scale, using 1 as very uncomfortable and 5 as very comfortable, comparing their comfort level prior to the project to their level of comfort after completing the project. Level of comfort with public speaking overall increased 1.32 points (2.78 prior to completion and 4.10 after). Comfort level associated with speaking to the media increased from 1.86 to 3.63. Level of comfort associated with discussing issues increased from 2.07 to 4.06. A second scale was used to determine students' perceived change in level of knowledge about current issues, average response = 4.67 (1 = none to 5 = a tremendous amount). Response to open-ended questions also indicated an increased level of awareness, understanding and concern for issues and public perception. Results indicate that this project increased students' understanding of the issues and societal perceptions surrounding food production, and equipped them with skills to educate others about these issues.

Key Words: teaching, industry, issues

326 Pork Industry Fellows Program in animal science at Iowa State University. T. J. Baas*, M. G. Hogberg, and A. E. Christian, *Iowa State University, Ames.*

The Pork Industry Fellows Program is a course taught in the Department of Animal Science at Iowa State University that is designed for undergraduate students who have a sincere interest in a career in the pork industry after graduation. Students currently learn swine management principles and concepts by completing science-based courses in the Animal Science curriculum at ISU. The Pork Industry Fellows Program then provides a unique opportunity for students who desire to work in some facet of the pork industry to better understand how the pork industry functions and how various components of the industry interact. Through a combination of industry field trips and experiences, students gain valuable knowledge that is generally not possible in the traditional classroom setting. Specific program objectives are for students to: 1) Gain an understanding of the integration and application of swine management principles to the pork industry; 2) Understand the structure of the pork industry and how segments of the industry work together; and 3) Interact with industry leaders to examine how decisions are made and prioritized. All applicants to the program must be enrolled as undergraduate students at ISU and have completed Animal Science 225, Swine Science, with a grade of B or higher in the course. Applicants must be able to demonstrate a sincere interest in a career in the pork industry and communicate how participation in the Pork Industry Fellows Program will be beneficial to them in reaching their career goal. Program objectives are met through a variety of learning experiences including classroom discussions with guest speakers, participation in field trips, and industry experiences. Through these activities, students gain an understanding of the role that various segments play in the pork industry. The Pork Industry Fellows Program teaches students about the pork industry and lays the foundation for future success in their chosen careers.

Key Words: career, student, teaching

327 Training students to be advocates for the animal industry through the class - Current issues in animal and range sciences. R. C. Thaler* and K. W. Bruns, *South Dakota State University, Brookings.*

As livestock producers face more county, state, and federal regulations, it is essential that they are able to effectively communicate their position. Agricultural leaders must be credible spokespeople for their industry, and be able to educate the non-ag community on their side of the issues in order to achieve manageable regulations. To help graduates of the SDSU Dept of Animal and Range Sciences fulfill that role, the traditional Senior Seminar class was converted to Current Issues on Animal and Range Sciences in 1990. The four main objectives of the class are to: 1) Increase student awareness of external factors, ethical beliefs, and governmental policies that impact the livestock industry; 2) Broaden student perspectives of issues by developing their ability to evaluate issues from unfamiliar viewpoints; 3) Enhance abilities to debate current issues and topics using factual, scientifically based information; 4) Enhance written communication skills through a variety of writing assignments, including a research based fact sheet and persuasive articles for the popular press. These objectives are achieved through a variety of assignments, with the greatest number of points assigned to a 15 minute presentation and a white paper on a controversial issue within the animal and range industries. Students randomly select their topic from a pre-determined list, and then using refereed journals and other resources, develop a paper and PowerPoint presentation that cover what

the issue is, why it's important, its pros, its cons, and what they believe is the right answer based on all their research. After their presentation, each student is responsible for leading a 10-minute question and answer session, and participation is graded. Other activities include Letters to the Editor and a critique of YouTube videos pertaining to agriculture. Students tend to be aware of one side of the issue before class, but after the class is over, most students indicate their understanding of the topic has been greatly enhanced and their perspective broadened.

Key Words: undergraduate, leadership, seminar

328 The Nebraska Beef Industry Scholars program. M. L. Spangler*, M. K. Nielsen, D. Brink, G. E. Erickson, J. Ellis, D. Mark, D. Burson, D. Smith, and B. Lubben, *University of Nebraska, Lincoln.*

The Nebraska Beef Industry Scholars (NBIS) program was designed to provide undergraduate students with an interest in the beef industry an opportunity to expand their knowledge through a specialized set of courses that are offered in addition to those required for an undergraduate degree. NBIS is proposed as a certificate program within the College of Agricultural Sciences and Natural Resources (CASNR) at the University of Nebraska-Lincoln. Courses within the NBIS program begin during the spring of a student's freshman year and conclude with a capstone course during the spring semester of their senior year. Students included in the program are selected via an application process during their fall semester as freshman. Course content includes seminars by industry personnel, issues-based courses demanding in-depth analysis of current topics and communication strategies to deal with potential industry crises, the development of a beef summit in conjunction with Nebraska Cattlemen, a course centered on the development and analysis of national policy, and an industry study tour. Total credit hours required for completion of the program ranges between 19-20, some of which will count towards undergraduate major requirements. At least one comprehensive internship is also required. In all courses, both written and oral communication skills are strongly emphasized. The program is currently in its fourth year and to date, thirty-six students are either enrolled or have graduated from it. Students in the program currently represent five majors within CASNR. The home departments of instructors are as varied as the departments represented by the students. The program does not accommodate transfer students given that one goal is to increase undergraduate student enrollment and freshman recruiting within CASNR. A primary benefit of NBIS is that students garner fundamental knowledge in the basics of beef cattle production while being strongly supplemented with knowledge from industry personnel. The proposed outcome of the program are graduates that have a strong knowledge base that can become effective advocates and leaders for the beef industry regardless of their career path.

Key Words: beef cattle, undergraduate teaching

329 Equine issues and leadership: Preparing emerging leaders to be advocates for the equine industry. R. C. Bott*, *South Dakota State University, Brookings.*

The Equine Issues and Leadership course was added to a diverse 14-class equine curriculum in 2009 to serve as a capstone class for juniors and seniors with a sincere interest in serving as leaders in the equine industry. Students who enroll in this class must have successfully completed a course in equine nutrition or reproductive management. The course

was designed to enable students to become fluent in major issues facing the equine industry while developing writing and speaking proficiency. Specific objectives included: 1) self development, 2) service, 3) underlying industry issues, and 4) team based strategic planning on the topic of horse slaughter. Initially, students worked on a self development plan including resume and cover letter building while networking with guest speakers and industry leaders. Students also participated in community service at an equine educational event for a local youth group. Each student chose two current issues in the areas of equine nutrition, health, reproduction, or industry to write papers that were subjected to peer revisions. This served to increase readability and to educate fellow classmates on a variety of topics. Finally, students worked in teams to prepare papers and presentations to address the issues of horse slaughter from history to legislation and economic impact. Each team was charged with presenting the facts, developing a strategic plan to educate the public, and implementing solutions. All of the papers were integrated into a class thesis and presentation which can, in turn, be used to educate the public. As indicated in a mid-term class survey, students placed high value on learning about and advocating for equine issues (9+ out of 10). They rated their knowledge of equine issues as a 5.75 out of 10 walking into class, and are confident that their knowledge increased by mid-term with a rating of 8.75 out of 10 ($P < 0.001$; $n=12$ students). As a result of participating in class, students will be better prepared to enter careers in the industry equipped with knowledge of industry issues and how to effectively communicate about the issues.

Key Words: leadership, students, equine

330 Beef leaders program at South Dakota State University. S. J. Winterholler* and K. W. Bruns, *South Dakota State University, Brookings.*

A 2008 survey of students in the Animal and Range Sciences Department at South Dakota State University indicated that beef cattle was the primary species of interest for 56% of freshman; of these 56%, 77% wish to return to the family farm or ranch. Only a small percentage of SDSU undergraduate students are involved in a beef organization during their college career; coursework alone does not provide adequate industry contact or exposure to beef production issues on state and national levels. Also, industry related issues continue to become more complex; students must be aware of and understand how to work through these issues. The purpose of this program is to: 1) engage critical thinking; 2) enhance the skills of communication and teamwork through group projects; 3) provide student opportunities for networking with beef industry leaders. The first yr of the 2-yr program consists of a monthly lectureship series; well-respected industry professionals of diverse backgrounds and industry interest are brought to campus to share industry perspectives with students. The second yr is devoted to group work related to beef industry issues, travel to the National Cattleman's Beef Association annual meeting, visit to the state capital, attendance of state commodity group meetings and a regional industry tour. Program commitment will be gauged by participation in the lectureship series; an application for the program will be due at the end of the lectureship series and will include summaries from lectures attended, background information, future goals and a plan of study. Evaluation of the program will be assessed by an initial and final survey of current students with respect to their awareness of beef industry issues, capability of dealing with industry related issues, knowledge of beef industry officials and level of industry involvement. With time, past Beef Leader participants and industry professionals will be contacted to evaluate the impact of the program. The numerous opportunities for industry interaction and

focus on critical thinking and communication skills that encompass the Beef Leaders Program will provide students with skills necessary for lifelong success.

Key Words: beef, teaching, undergraduate

331 Incorporation of a student response system into a large animal nutrition lecture course. B. J. Bradford*, *Kansas State University, Manhattan.*

Student engagement can be problematic in large lecture settings, but several new technologies offer options for increasing instructor/student interactions. Among the most popular technologies being introduced on campuses are student responses systems (SRS), using devices often referred to as "clickers". Use of an SRS was incorporated into a sophomore/junior level fundamentals of nutrition course at Kansas State University in the fall semester of 2008. Course material was delivered in 50-min lectures 3 times per week, and 135 students completed the course. Lectures were designed with in-class questions presented at approximately 10-min intervals throughout the lectures. Student responses to questions were displayed in histograms during class and individual answers were scored for participation points. In-class participation accounted for 10% of the final course grade. Students were polled regarding their experiences with the SRS during the final lecture of the semester, with 117 students responding. Mean lecture attendance for the course was 88%, and 75% of students indicated that the SRS and participation points resulted in greater class attendance. Students believed that use of the SRS improved learning outcomes; 89% indicated that in-class questions made them think about the material more deeply and 64% said that the questions helped them prepare for quizzes and exams. In addition, 89% agreed that the SRS made them more attentive in class, and the same percentage indicated that the SRS improved the course overall. A majority of students (74%) indicated that they were willing to purchase an SRS device, as long as it could be used in multiple classes. However, only 1.7% were willing to do so if participation points were not awarded. In summary, use of an SRS in a large lecture course seemed to improve attendance, attentiveness, and self-assessed learning, yet student motivation to use the SRS is driven largely by the ability to earn credit for class participation.

Key Words: student response device, engagement, teaching

332 Swine science online. T. J. Baas*¹, M.T. See², J. Sterle³, D. Meisinger¹, and C. Masker¹, ¹*Iowa State University, Ames*, ²*North Carolina State University, Raleigh*, ³*Texas A&M University, College Station.*

Swine Science Online is a distance-based education program comprised of 15 courses and 2 resident lab courses. These courses make up a program within Ag*Idea, a national consortium of land grant universities offering programs and courses in agriculture disciplines. The Swine Science Online program is targeted toward students who are earning a 4-year degree, with a secondary audience of individuals currently working in the pork industry and looking to further their education. The online-based program makes swine specific courses more available to students by providing them the opportunity to take swine science courses that are not offered at their own university. The program will target students who are seeking to be managers of production units, those who will see seek employment in allied industry, and those who will be future

leaders in the pork industry. The courses that make up this university program will focus as much on theory as they do on real world application. The goal of the Swine Science Online program is to teach students the problem solving and analytical skills that will be needed in the pork industry today and in the future. In developing the courses, professors with swine experience from across the country serve as curriculum leaders and instructors. Also, students and pork producers from across the country provided input during the development process as reviewers of content. Currently, the courses are being beta-tested by students at universities across the U.S. After completion of the courses, students participate in a course evaluation. Results of the evaluation are used to improve the courses. Current courses include: Basic Swine Science, Basic Lab, Advanced Lab, Breeding and Gestation, Farrowing Management, Nursery and Finishing Management, Employee Management, Contemporary Issues, Health and Biosecurity, Global Swine Industry, Marketing and Risk Management, Business and Records Analysis, Environment Management, Manure and Nutrient Management, Pork Product Quality and Safety, and Feed Mill Management.

Key Words: career, student, teaching

333 Outcome/assessment activities for the animal sciences curriculum at Purdue University. M. Diekman*, *Purdue University, West Lafayette, IN.*

For Purdue University to continue its teaching mission, it must be reaccredited by the Higher Learning Commission by 2010. To accomplish this task, the College of Agriculture identified nine learning outcomes:

professional preparation, scientific principles, critical thinking, communication, teamwork, cultural understanding, social science principles, civic responsibility and lifelong learning. In 2005, communication was targeted as the learning outcome at the level of the College of Agriculture. Performance criteria examined were organization, amount and quality of information, mechanics, paragraph construction and content/relevancy to animal sciences. For the animal science curriculum, scientific merit was identified as the outcome. Initially, all course syllabi were examined to determine overlap and voids in courses within the discipline areas. Utilizing the matrix rubric, courses were scored using Bloom's taxonomy for understanding scientific principles, applying knowledge and solving problems. Following a departmental retreat, the undergraduate programs committee summarized philosophical concerns, curricula concerns, option/specialization modifications and individual course changes. With input from senior exit interviews, alumni surveys, stakeholder and employers interviews and the animal science advisory board, several modifications were incorporated into the animal science curriculum. To strengthen communication skills, additional writing and oral presentations were added to the capstone requirement of contemporary issues in animal sciences and a species production management enterprise analysis. From the rubric, it was determined that completeness (3.1/4) and documentation (3.2/4) received the lowest scores. From 2006-2008, over 300 seniors took a basic principle test on nutrition, physiology, genetics, production/management and products. The average score was 33% indicating that students are geared towards short-term memory and the value of life-long learning is under appreciated.

Key Words: curriculum, learning outcomes, assessment

Undergraduate Student Oral Competition

334 Late castration increases observed scrotal hernias and reduces the number of irreparable scrotal hernias. K. L. Marcath*^{1,2}, E. J. Ehinger¹, D. J. Mulder¹, and T. M. Seals¹, ¹*Sandy Ridge, Dykhuis Farms Inc., Holland, MI*, ²*Michigan State University, Department of Animal Science, East Lansing.*

A common problem in commercial swine facilities are scrotal hernias (ruptures) often observed around the time of castration. The prevalence of scrotal hernias in pre-weaned pigs is about 0.5 to 1.5% (Vogt and Ellersieck, 1990). Increasing the number of observed and repaired hernias could result in less mortality prior to weaning. This study was conducted to determine whether castration age would impact number of irreparable ruptures and incision healing at weaning. Intact male pigs (n = 3080) from 602 crossbred litters were sired by mixed semen (327 line PIC boars). Since breed differences exist with regard to prevalence of scrotal hernias, maternal genetics were randomly selected throughout nine rooms within a farrow-wean unit. Intact males were castrated at 4 to 6 (EC) or 8 to 10 (LC) d of age. All males within each litter were castrated at the same age. When picked up for castration, pigs were observed for rupture which was defined as protrusion of intestine in the scrotal area. If a rupture was found prior to castration, it was surgically corrected. However, if a rupture was found during or after castration, the rupture was corrected with tape. At weaning, a sub-sample of barrows (n = 936) were inspected for incision healing and classified as completely healed or not healed. Healed incisions were defined as minor to no scabbing and no signs of infection. The percent of scrotal hernias noticed prior to castration was greater in LC than in EC boars (0.63% vs. 0.20%, *P*

< 0.05). The number of ruptures observed after castration was not different with regard to castration age. In the same sub-sample of barrows examined for incision healing at weaning, more LC were fully healed than EC (13.9% vs. 8.6%, *P* < 0.0001). Healing time greater than 13 d did not result in a greater number of healed pigs (*P* < 0.05). Therefore, later castration resulted in fewer irreparable ruptures and improved healing which may reduce death loss.

Key Words: pig, castration, rupture

335 Postpartum feeding behavior of dairy cows fed ad libitum or restricted prepartum diets containing wheat straw or orchardgrass. B. Weich*, A. D. Kimicikewycz, M. I. Endres, and N. B. Litherland, *University of Minnesota, St Paul.*

The objectives of this study were to investigate the effects of forage type and amount of DM fed during the dry period on dairy cow behavior. Diets containing wheat straw require longer eating time, are less digestible, and may result in smaller and more frequent meals than diets containing grass hay. A 2 × 2 factorial design was used to determine the effects of forage type (wheat straw (WS) vs. orchardgrass hay (OG)) and amount fed (ad libitum (AL) vs. 30% intake restriction (R) in DM based on NRC, 2001) on behavior and DMI from 5 d before to 5 d after calving. Treatments included WS TMR AL (WSA); GH TMR AL (GHA); WS TMR R (WSR); GH TMR R (GHR). The WS TMR (DM basis) contained 30% WS, 21% corn silage, 10% alfalfa hay, 18% ground corn, 17% soybean

meal, and 4% molasses (15% CP, 0.30 NE^L Mcal/kg, 37% NDF). The OG TMR contained 30% OG, 46% corn silage, 10% alfalfa hay, 10% soybean meal, and 4% molasses (15% CP, 0.30 NE^L Mcal/kg, 40% NDF). All cows received one lactation diet after calving. Twenty-three cows were used in the behavior analysis. Feeding and lying behavior were scored with scan sampling at 10-minute intervals from 24-h video and observed from d -5 to d +5 relative to calving. We hypothesized the WSA would result in more feeding bouts prepartum, and increased postpartum feeding bouts compared with GHA; in addition, AL would have more frequent feeding bouts than R. Week 1 prepartum DMI was higher ($P < 0.05$) for AL compared to R and tended ($P = 0.07$) to be higher for AL compared to R fed cows week 1 postpartum. Prepartum dietary treatment had no significant effect on feeding bouts, feeding time, or lying time. Prepartum feeding bouts were numerically greater for AL compared to R. A treatment by day interaction was observed postpartum; WSA had more feeding bouts than GHA on d +2 ($P < 0.05$) and tended to have more ($P < 0.06$) on d +4. WSR tended ($P = 0.06$) to have more feeding bouts than GHR on d +2. GHA had more feeding bouts than GHR on d +3 ($P < 0.05$). These results indicate that forage type and amount fed could have some effects on feeding behavior of transition cows.

Key Words: prepartum diet, nutrient intake, feeding behavior

336 Early finishing performance of pigs fed treatment of Denagard plus chlorotetracycline vs. oxytetracycline in grower diet. J. Graham^{*1}, D. Dau², and J. Waddell³, ¹South Dakota State University, Brookings, ²Novartis Animal Health, Greensboro, NC, ³Sutton Veterinary Clinic, Sutton, NE.

A feed-and-weigh demonstration was conducted during the first 15 days after placement into the finishing phase in two rooms of an 18,000 head capacity finishing site which was part of a 45,000 sow multi-sourced system. The objective was to evaluate the performance (ADG and mortality) of pigs fed a standard diet with 35g/ton Denagard (tiamulin) plus 400g/ton chlorotetracycline (CTC) compared to a standard diet containing 500g/ton of oxytetracycline (OTC). The two rooms were stocked at 35 pigs/pen in 28 of the 30 pens, leaving two pens as hospital pens, totaling 980 head. The north pens of the first room were fed the Denagard/CTC treatment and the OTC treatment fed to the south pens. The treatments for north and south pens of the second room were opposite. A person blinded to the treatments randomly selected 8 pigs/pen by marking every 4th pig. The experimental unit was the pen. The pigs were weighed and tagged on day 0, and weighed again on day 15. The pigs were healthy upon placement and averaged a weight of >66lbs. Clinical signs of a significant disease challenge were not observed during the 15 day period. Pigs in the Denagard/CTC treatment group gained an average of 2.1 lbs more than pigs in the OTC treatment group ($P < 0.01$). Mortality was low with no difference between treatment groups. The results of this demonstration indicate that the extra cost of \$0.23/head for the Denagard/CTC treatment was justified by the extra 2.1 lbs per pig gained in the 15 day period.

Key Words: swine, finishing pigs, growth performance

337 Effects of maternal nutritional plane and selenium supply on jejunal crypt cell proliferation and villous morphology in offspring at 20 days of age. S. I. Fry^{*1}, A. M. Meyer¹, J. J. Reed¹, T. L. Neville¹, J. B. Taylor², L. P. Reynolds¹, D. A. Redmer¹, K. A. Vonnahme¹, and J. S. Caton¹, ¹Center for Nutrition and Pregnancy, Department of Animal Sciences, North Dakota State University, Fargo, ²USDA-ARS, U.S. Sheep Experiment Station, Dubois, ID.

To examine the effects of nutritional plane and Se supply during gestation on lamb jejunal crypt cell proliferation and villous morphology, 84 Rambouillet ewe lambs were randomly assigned to a 2 x 3 factorial design. Treatments included adequate Se (ASe, 11.5 µg/kg BW) or high Se (HSe, 77 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, fed artificial colostrum, and then allowed ad libitum access to milk replacer. At 20.6 ± 0.9 d of age, lambs were euthanized and necropsied. Jejunal samples were immersion fixed and embedded in paraffin, sectioned and stained, and images were taken for analysis of proliferating cells, villous height, and crypt depth. Data were analyzed for effects of Se supply, nutritional plane, and their interaction. Within offspring born to ASe ewes, those from ewes fed the HIGH diet had greater ($P = 0.003$) percent proliferating jejunal cells (7.35 vs. 3.78 ± 0.94%) and proliferating:non-proliferating cells than CON. In addition, offspring born to ewes fed ASe and the HIGH plane of nutrition had greater ($P = 0.003$) percent of proliferating jejunal cells (7.35 vs. 3.56 ± 0.94%) and proliferating: non-proliferating cells compared to HSe-HIGH. Offspring born to HIGH fed ewes had a greater ($P = 0.03$) total number of small intestinal cells compared to RES, with CON being intermediate. Offspring born to ASe-HIGH fed ewes also had greater ($P < 0.001$) total proliferating intestinal cells than all other treatments. There were no differences ($P \geq 0.17$) in jejunal crypt depth or villous length due to maternal treatments. These data are interpreted to indicate that maternal nutritional plane and Se supply can significantly affect jejunal crypt cell proliferation in 20-d old offspring. These observations may partially explain other effects of gestational nutrition on offspring growth, health status, and intestinal function that are present even after similar postnatal management.

Key Words: cell proliferation, gestational nutrition, intestine

338 Evaluation of single nucleotide polymorphism markers on pig chromosomes 3 and 6 for potential associations with meat quality traits. M. J. Dawes^{*}, R. O. Bates, N. E. Raney, J. P. Steibel, and C. W. Ernst, Michigan State University, East Lansing.

We previously identified meat quality QTL on pig chromosomes 3 and 6 (SSC3 and SSC6) in a Duroc × Pietrain resource population. The objective of this study was to evaluate these QTL in a Yorkshire × Landrace crossbred population by genotyping single nucleotide polymorphisms (SNP) within these QTL regions. Pigs were produced in four replicates and phenotypic traits measured included loin muscle pH at 45 min (pH45) and 18 h (pHu), CIE L*, a* and b*, drip loss percent, color (1-6) and marbling (1-10) score, and ADG. Gene-specific SNP markers were chosen from our previous work or from publically available sources. Genotyping was performed using Illumina Goldengate assays and an Illumina BeadXpress Reader. A total of 18 and 19 markers were genotyped for the SSC3 and SSC6 QTL regions, respectively, of which 12 SSC3 and 10 SSC6 markers were segregating. Data from pigs with both phenotype and genotype records (n=327) were analyzed

using a model that included the fixed effects of genotype and sex, and the random effects of replicate, litter and slaughter date. Analysis of ADG included covariates of weaning weight and days from weaning to market. Additive effects were estimated by comparison of homozygous LS means, whereas dominance effects were calculated as deviations of heterozygotes from the average of the homozygotes. Nine SSC3 SNP markers were significantly associated with one or more meat quality traits ($P < 0.05$), including KCNS3 for pH45, and KIAA1310 and PMM2 for pHu, consistent with our previously identified QTL for pH traits in this SSC3 region. Both KCNS3 and PMM2 exhibited significant additive effects ($P < 0.03$). Three SSC6 markers were significantly associated with marbling score ($P < 0.03$), consistent with our previous observations of QTL for various fat-related traits in this SSC6 region. Two markers (LEPR and CNKSR1) exhibited additive effects ($P < 0.02$). These results support associations of genes located in previously identified QTL regions with meat quality traits. Further analysis of the effects and interactions of these genes will clarify their potential roles in improving meat quality traits.

Key Words: pork quality, QTL, SNP

339 Supranutritional selenium during pregnancy increases ovine mammary gland vascularity. C. M. Jorgenson*, P. P. Borowicz, J. S. Caton, D. A. Redmer, L. P. Reynolds, and K. A. Vonnahme, *Center for Nutrition and Pregnancy, Department of Animal Sciences, North Dakota State University, Fargo.*

Maternal nutrient restriction during gestation reduces milk production compared to moderately or overfed ewes. Moreover, ewes fed supranutritional levels of Se during pregnancy had increased milk production compared to ewes that were fed an adequate amount of Se. Proper blood flow to the mammary gland is necessary for maintained milk production. We hypothesized that maternal diet during gestation may influence mammary gland vascularity. To examine effects of supplemental Se and maternal nutritional plane on mammary gland vascularity in ewes, treatments were imposed on 82 pregnant Rambouillet ewe lambs (52.2 ± 0.8 kg) allotted randomly to 1 of 6 treatments in a 2×3 factorial. Factors were Se supply ($9.5 \mu\text{g Se}\cdot\text{kg BW}^{-1}\cdot\text{d}^{-1}$ [ASe] and $81.8 \mu\text{g Se}\cdot\text{kg BW}^{-1}\cdot\text{d}^{-1}$ [HSe]) and maternal nutritional plane (100% of ME requirement [CON], 60% of CON [RES], and 140% of CON [EXC]). Selenium treatments were initiated at breeding and nutritional plane treatments at d 50 of gestation. Mammary glands were collected 1 d postpartum and perfusion fixed for vascularity analysis. Vascularity was determined by: cross-sectional capillary area density (total capillary area as a proportion of tissue area), and capillary surface density (total capillary circumference per unit of tissue area). Vascular microanatomy was analyzed using Image-Pro Plus software. Selenium supplementation increased capillary area density ($P < 0.01$; 0.135 vs. 0.104 ± 0.002). There was a Se by nutritional plane interaction ($P = 0.07$) for capillary surface density. When ewes were fed ASe, RES and EXC ewes had decreased ($P < 0.10$) capillary surface density compared to CON ewes. There was no effect of nutritional plane on capillary surface density within the HSe fed ewes. Moreover, HSe-RES and HSe-EXC ewes had greater ($P < 0.05$) capillary surface density than ASe-RES and ASe-EXC ewes. Supranutritional levels of Se increases capillary development in the mammary gland and may influence milk production.

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Key Words: mammary gland, selenium, vascularity

340 Effect of organic and inorganic zinc supplementation on expression of key antioxidant genes in weanling pigs. R. L. Wangler*¹, P. S. D. Weber¹, J. E. Link¹, D. C. Mahan², and G. M. Hill¹, ¹Michigan State University, East Lansing, ²The Ohio State University, Columbus.

Zinc (Zn) is an essential trace element that at pharmacological concentrations affects genes involved in oxidative stress and amino acid metabolism. However, it is not known if Zn supplementation at physiological levels affects gene expression similarly. Therefore, the objective of our study was to evaluate the effect of Zn supplementation at NRC levels to weanling pigs on expression of Metallothionein (MT), Peroxiredoxin 4 (PRDX4), Glyoxalase (GLO1), and Aminoacylase 1 (ACY1). At weaning, 9 pigs were allotted to 3 pens on the basis of weight, gender, and litter. Each pen was fed 1 of 3 diets, which included 1) basal diet (no Zn, but other trace minerals at 100% NRC level), 2) basal diet + 100 ppm Zn Bioplex, and 3) basal diet + 100 ppm Zn sulfate. At 10 d, pigs were killed and liver samples collected for subsequent RNA isolation. RNA was isolated using 5 Prime Perfect Pure RNA Cell and Tissue Purification Kit per manufacturer's instructions and RNA purity, integrity, and quantity were determined using the Agilent Bioanalyzer. RNA samples with RNA Integrity Number (RIN) ≥ 9.0 were then converted to cDNA using Applied Biosystems High Capacity cDNA kit. Quantitative Real Time Polymerase Chain Reaction (qRT-PCR) was used with Taqman Gene Expression Master Mix, gene specific primers, and Taqman probes to measure expression levels of MT, PRDX4, GLO1, ACY1 and β -Actin. Delta delta Ct method and SAS linear mixed models were used to determine expression differences between treatments. MT gene expression was significantly higher ($P \leq 0.05$) in livers from pigs fed Zn supplemented diets. MT expression in pigs fed Zn Bioplex and Zn Sulfate was > 4 fold higher than in the basal diet. Zn Bioplex and Zn Sulfate diets did not differ in MT expression ($P = .31$). Expression of PRDX4, GLO1, and ACY1 were not different ($P \geq .22$) between the 3 diets. Supplementation of organic and inorganic Zn to pigs enhances gene expression of a key antioxidant gene, MT, and may improve the animal's ability to combat oxidative stress.

Key Words: pigs, zinc, antioxidant genes

341 Protein denaturing condition of beef inside semimembranosus muscle caused less protein degradation and μ -calpain autolysis than outside semimembranosus. A. N. Fritchen*, Y. H. Kim, J. J. Hosch, S. M. Lonergan, and E. Huff-Lonergan, *Iowa State University, Ames.*

The beef semimembranosus (SM) muscle often appears a two-toned color, exhibiting a paler color in the inside SM (ISM) than outside SM (OSM). Because of the size, thickness, and location of the SM, the ISM has a slower chill rate and more rapid pH decline than OSM at early postmortem. This results in muscle protein denaturation. Therefore, we hypothesize the protein denaturing condition of ISM will negatively influence postmortem proteolysis by decreasing μ -calpain activity. The objective of this study was to determine the influence of biochemical characteristics of beef ISM and OSM on postmortem protein degradation. At 24 h postmortem, the SM was removed from beef carcasses ($n = 10$), packaged in high-oxygen modified atmosphere ($80\% \text{O}_2 + 20\% \text{CO}_2$), and displayed for 7 d at 1°C . Instrumental color, pH, protein denaturation, western blotting for μ -calpain autolysis, desmin, and troponin-T degradation were determined. Type-3 tests of fixed effects for muscle location and display time, and their interaction, and a random effect for animals were analyzed by using the Mixed Model procedure

of SAS for ANOVA. Location did not affect pH at 24 h postmortem. However, ISM had a higher ($P < 0.05$) L* (lightness), a* (redness), b* (yellowness), and hue (discoloration) values than OSM. ISM also had higher ($P < 0.05$) protein denaturation values than OSM. The western blotting of desmin and troponin-T found that ISM had less ($P < 0.05$) protein degradation than OSM throughout display time. Western blotting for μ -calpain autolysis revealed that at 48 h postmortem ISM maintained unautolyzed μ -calpain subunit (80-kDa), whereas OSM had mostly autolyzed subunits (78- and 76-kDa). These results confirm our hypothesis that increased protein denaturation of ISM resulted in minimal proteolysis by negatively affecting μ -calpain activity, which could subsequently lead to decrease meat tenderness. Implementation of efficient chilling techniques to prevent protein denaturation in the interior of the semimembranosus should improve consistency and quality of fresh beef cuts from the top round.

Key Words: μ -calpain, protein denaturation, proteolysis

342 Environmental benefits from the use of ractopamine in feedlot cattle. T. M. Hodge*, D. R. Ames, S. L. Archibeque, and D. B. Anderson, *Colorado State University, Ft. Collins.*

The environmental benefits were estimated for the use of ractopamine (Optaflexx) in feedlot cattle at a dose of 20 ppm for the last 35 days of feeding. Data from the CSU Beef Improvement Center (BIC) were used for breeding cows and for calves going directly from weaning to growing/finishing diets in the feedlot. Using published data on the increase in carcass protein from the use of ractopamine, we calculated a decrease of 5.5 percent in market cattle (1.51 million head) required to produce the same amount of beef protein. When weaning percentage is considered this would result in a decrease of 1.72 million breeding cows and 340,000 replacement heifers. We assumed the breeding cows at BIC consume 1820 kg of hay that provides 9822 MJ of NEm, and 1270 kg of pasture that provides 5798 MJ of NEm annually (DM basis). These cows consumed an estimated 15620 MJ per year that requires 4 ha for pasture and hay in SE Wyoming. These calculations suggest a potential savings in the US cow herd of over 5 billion kg of hay equivalent annually. The feedlot cattle consumed an average of 1087 kg of corn, 584 kg of dried distiller grains, 65 kg of soybean meal, and 291 kg of wheat hay (DM basis). These feed consumption values suggest potential savings of over 3 billion kg of feed in the US during the feedlot phase translating into substantial reductions in land, water, chemical/fertilizer, and energy consumption related to crop and livestock production. Since decreases in animal numbers reduce overall inputs required for beef cattle production, the results of these estimates demonstrate that widespread use of ractopamine could positively impact the environment by reducing resources needed for beef production.

Key Words: environment, beef cattle, Optaflexx

343 Transcript profile of hexose transporters along the horse gastrointestinal tract. N. P. Taylor*¹, A. D. Woodward¹, R. Manjarin¹, S. J. Holcombe², and N. L. Trotter¹, ¹Michigan State University, Department of Animal Science, East Lansing, ²Michigan State University, College of Veterinary Medicine, East Lansing.

Dietary carbohydrate imbalances and hexose mal-absorption in horses have been implicated in the etiology of many metabolic disorders such as laminitis and colic. To test the hypothesis that glucose and fructose

transporter transcripts are in lower abundance in the large intestine compared to the small intestine of the horse, mRNA of candidate genes encoding for hexose transporter proteins were quantified in small and large intestinal segments of the horse. Four adult horses euthanized due to illness unrelated to gastric disturbances were used. Mucosal samples were taken from two segments of the small intestine, i.e., distal jejunum and ileum, and three segments of the large intestine, i.e., cecum, left ventral colon and left dorsal colon. Complementary DNA was manufactured from all samples and mRNA abundance of candidate hexose transporter genes determined using relative quantitative PCR. Primers for genes SLC2A1, SLC2A2, SLC2A5, and SLC5A1, respectively encoding for hexose transporters GLUT1, GLUT2, GLUT5, and SGLT1, were designed using gene sequences from GenBank. The $2^{-\Delta\Delta C_T}$ method was used to compare the candidate hexose transporter gene mRNA abundance in the ileum, cecum, left ventral colon and left dorsal colon to that of the jejunum, with GAPDH and β -actin serving as housekeeping genes. Relative to the jejunum, abundance of GLUT1 was not different in the ileum and left ventral colon and increased in the cecum ($P = 0.02$) and left dorsal colon ($P \leq 0.01$). Transporters GLUT2, GLUT5 and SGLT1 mRNA abundances were not different in the ileum and decreased in the cecum ($P \leq 0.01$), left ventral colon ($P \leq 0.001$) and left dorsal colon ($P \leq 0.01$) relative to the jejunum. The majority of the hexose transporters examined were in low abundance in the large intestine, indicating that there is no significant absorption of glucose, galactose or fructose across the large intestine of the horse. The physiological relevance of increased transcript abundance of GLUT1 in the equine large intestine is unclear.

Key Words: horse, hexose, intestine

344 Effects of maternal exercise during gestation on blood oxygen levels and gilt behavior. C. G. Jackson*, E. K. Harris, K. A. Vonnahme, and E. P. Berg, *Department of Animal Sciences North Dakota State University, Fargo.*

To examine the effects of exercise on blood oxygen levels and maternal behavior during pregnancy, Yorkshire gilts ($n = 10$; 172 ± 3.9 kg) were bred to a common boar and were placed in gestation stalls on d 30 (d 0 = breeding). On d 40 of gestation, gilts were randomly assigned to either remain in a gestation stall for the duration of pregnancy (CON) or to undergo an exercise treatment (EX). On d 40 and 41, individual gilts were allowed to walk at their own pace for 10 min. On d 42 and 43, gilts walked 20 min. From d 44 and every Monday, Wednesday, Friday, gilts walked for 30 min until d 105 of gestation. To record activity in EX gilts, number of steps taken during each exercise bout was recorded by pedometers. Pulse oximetry meters were used to record blood oxygen levels of resting gilts. Preliminary measurements were taken at d 39 of gestation, prior to exercise treatment initiation, and were carried out every 14 d. Maternal behavior was monitored via continuous video recording on d 89 and 90 and data was averaged. Measures of interest were duration of laying, sitting, or standing and number of postural changes. Number of steps increased ($P < 0.01$) from d 40 until peaking at d 46, remaining steady until d 105. Treatment did not affect ($P = 0.44$) blood oxygen saturation, but there was a day effect ($P = 0.05$) with oxygen saturation fluctuating every 2 wk. While exercise did not affect ($P = 0.83$) the duration of time gilts were laying down (~ 21 h), EX gilts sat less ($P < 0.01$; 4.3 vs. 17.3 ± 2.9 min), and tended to stand more ($P = 0.07$; 161.4 vs. 126.3 ± 12.8 min) than CON gilts. The number of posture changes was reduced ($P = 0.04$) in EX gilts vs CON gilts (37 vs. 52 ± 4.5), indicating CON gilts were more restless. It appears that the exercise treatment did not negatively affect pregnant

gilt behavior. Impact of maternal exercise on offspring growth and performance warrants study.

Key Words: exercise, swine, behavior

345 Evaluation of storage covers when wet distillers by-products are mixed and stored with forages. D. L. Christensen*, K. M. Rolfe, T. J. Klopfenstein, G. E. Erickson, and C. D. Buckner, *University of Nebraska, Lincoln*.

Wet distillers grains (WDGS) or distillers solubles were mixed with forage and stored in 208 L barrels to assess spoilage and loss with different covers to mimic bunker storage conditions. Barrels were undisturbed for approximately 45 d in temperature controlled rooms unless noted, with 3 or 4 replications per treatment. The mixes were a 70:30 ratio of WDGS:straw in Exp. 1, 2, and 3, and a 70:30 ratio of solubles:straw in Exp. 2. An open, uncovered treatment (CON), a plastic cover, and a treatment with salt applied to the surface at the rate of 4.9 kg/m² were evaluated in Exp. 1. Three covers evaluated with WDGS:straw mixtures included CON, solubles as a cover (7.5 cm), or a combination of solubles and salt in Exp. 2. The solubles:straw mix in Exp. 2 included CON and solubles (7.5 cm) as a cover. Cover treatments in Exp. 3 consisted of CON, solubles/salt combination similar to Exp 2, an uncovered treatment (CON) stored outdoors where temperature and moisture fluctuated, CON stored indoors with simulated rainfall (1.5 cm weekly), and a solubles/salt combination stored indoors with 1.5 cm rainfall weekly. Spoilage/loss was least ($P < 0.05$; 0.6%) with the plastic cover, most ($P < 0.05$; 7.4%) for CON, with the salt being intermediate in Exp. 1. Spoilage/loss were not different ($P > 0.10$) between solubles (2.1%) and solubles/salt (3.1%), but less ($P < 0.05$) than CON (7.9%) in Exp. 2. No difference ($P = 0.22$) in spoilage/loss was observed between CON and solubles as a cover for a 70:30 ratio of solubles:straw. An increase ($P < 0.05$) in spoilage/loss was observed when barrels were stored outdoors compared to indoors, but covering with solubles/salt reduced ($P < 0.05$) spoilage/loss. Across experiments, 28 to 50% of the solubles DM was lost when used as a cover. In vitro DM disappearance was not different ($P > 0.10$) between spoiled material and non-spoiled material. Plastic covering was the most effective at reducing losses and spoilage, followed by solubles, salt, or combinations of the two.

Key Words: spoilage, storage, wet distillers grains with solubles

346 Nutrient composition of spoiled and non-spoiled wet by-products mixed with straw after storage. J. R. Yelden*, C. D. Buckner, K. R. Rolfe, D. L. Christensen, T. J. Klopfenstein, and G. E. Erickson, *University of Nebraska, Lincoln*.

Cattle producers have an opportunity to purchase and store high energy wet byproducts mixed with cheap, poor quality forages to be fed later. In silos, spoilage results from this storage and spoiled material is fed, but the nutrient value of this spoilage is not known. Therefore, nutrient composition was conducted on spoiled and non-spoiled fractions of 70% wet distillers grains with solubles (WDGS) mixed with 30% straw or 60% solubles with 40% straw that were stored in 200 L barrels for 60 d. A 7 × 2 and a 2 × 2 factorial were designed for the WDGS and solubles barrels, respectively. The 7 WDGS treatments were kept in a building and included no cover with or without water added to the surface to simulate rain; covered with solubles, salt, or a mixture of solubles and salt; mixed solubles and salt with water added to the surface; and covered

with plastic. The 2 solubles treatments included no cover stored inside or outside to be exposed to rainfall. Each barrel (2/ covered treatment) was separated into spoiled and non-spoiled portions after storage. The WDGS and straw, uncovered barrels with no added water contained 23.2 cm of spoiled feed, which resulted in 8.1 pH, 26.7% CP, 4.9% fat, 52.9% NDF, and 12.0% ash compared to 4.1 pH, 24.9% CP, 10.6% fat, 42.2% NDF, and 8.1% ash for the non-spoiled feed. Interactions ($P < 0.01$) resulted between cover treatment and spoilage layer for pH, CP, fat, NDF, and ash with the WDGS and straw barrels. An interaction ($P < 0.01$) for CP also resulted from the solubles and straw barrels. Generally, the spoiled layer resulted in increased pH, NDF, and ash and decreased fat ($P < 0.01$) compared to the non-spoiled layer for both mixtures. Using solubles as a cover preserved the nutrient content of the spoiled fraction. Nutrient value of spoiled fractions of WDGS or solubles mixed with straw and stored in barrels decreases as a result of increased ash and NDF and decreased fat content.

Key Words: wet distillers grains with solubles, solubles, storage

347 Effects on ground or non-enzymatically browned flaxseed on apparent total tract digestion and plasma fatty acid profiles in steers. J. Miller*, C. Schneider, K. Miller, G. Parsons, L. Thompson, S. Uwituzo, and J. Drouillard, *Kansas State University, Manhattan*.

Growing beef steers ($n = 24$; 379 ± 6.4 kg BW) were used to evaluate effects of non-enzymatic browning of flaxseed (*Linum usitatissimum*) on assimilation of polyunsaturated fatty acids (PUFA) into plasma. We hypothesized that non-enzymatic browning would render protein resistant to microbial digestion, and in so doing make associated lipids less susceptible to biohydrogenation. Isonitrogenous diets (DM basis) were 40% corn silage, 3% corn steep liquor, supplement, dry-rolled corn, and either 3.87% corn oil (CO), 10% ground flaxseed (FLAX; 635 μ ; 20% UIP), or 10% non enzymatically-browned ground flaxseed (BFLAX; 733 μ ; 44% UIP). BFLAX was prepared by combining ground flax with live yeast (a source of carbohydrases) and solvent, steeping the mixture, then heating to 100C for 1 h. Cattle were stratified by initial BW, randomly assigned to diets (8 steers/diet), and allocated to individual pens. Diets were fed once daily at 0800 h. Chromic oxide (0.1% of DM) was added to diets to estimate apparent total tract digestibilities of diets and components thereof. On d 0, 7, 14, and 21, blood from each animal was used to measure plasma concentrations of long chain fatty acids. Diet did not affect apparent total tract digestibilities of DM, OM, CP, NDF, or starch ($P > 0.3$). Digestibility of lipid was less for CO than for FLAX ($P < 0.01$); BFLAX was intermediate and not different ($P > 0.08$) from other treatments (41, 70, and 56% for CO, FLAX, and BFLAX, respectively). Plasma total fatty acid concentrations were unaffected by treatment ($P > 0.3$), but concentrations of alpha linolenic acid (ALA) and eicosapentaenoic acid (EPA) were greater for steers fed FLAX or BFLAX ($P < 0.01$) compared to steers fed CO. Compared to FLAX, feeding BFLAX decreased plasma concentrations of ALA ($P < 0.05$), but EPA concentrations were not different ($P > 0.1$). Non-enzymatic browning was ineffective as a strategy to increase assimilation of PUFA from flaxseed.

Key Words: flaxseed, fatty acids, biohydrogenation

348 Evaluation of prototype and commercial sodium chlorite (base/activator) pre- post milking teat dips on teat end and teat skin condition and health. J. Juarez* and L. L. Timms, *Iowa State University, Ames.*

Objectives of these 2 trials were to evaluate 2 sodium chlorite pre-post teat dips (base and activator mixed each milking) compared to a commercial acidified sodium chlorite dip system (4-XLA, Alcide Corp.) on overall teat end and teat skin condition and health. Both trials utilized a half udder design with left teats dipped in control dip (4-XLA (C)) and right teats dipped with experimental products. Trial one utilized 96 cows over a 2 month evaluation period (Nov. 2008-Jan 2009) with left teats post dipped with C and right teats dipped with V (Vanquish, Delaval, Inc). All cows were predipped with the herd .25% iodine predip and dried with cloth towels prior to milking. Teat skin and teat end scoring were performed using a variation of the Goldberg and Timms methods, respectively (teat end hyperkeratosis and roughness scored independently), by a single trained grader. Scoring was

performed twice per week. Trial 2 utilized 48 cows over a one month period (Aug. 2009) with left teats pre and post dipped with C while right teats were dipped with B (Bi-Sept, GEA Technologies). Teat end and skin scoring methods were identical to Trial 1. Mixed procedure of SAS with repeated measures were used to analyze teat skin and teat end data, with $P < 0.05$ considered significant. GENMOD procedures of SAS with repeated measures was used to analyze % cracked/rough teat end data. There were no significant differences in teat skin and teat end condition and health (average skin and end scores or % of teats with rough ends) between control and experimental dips in either trial. However, in the winter trial, initial and overall trial teat end scores were significantly higher compared to the summer trial and there was a significant effect of day or date on teat end scores during this trial, signifying other factors affect teat condition (winter and weather). Overall, both experimental dips showed excellent teat health and condition and were not significantly different from the control commercial teat dip.

Key Words: sodium chlorite teat dip, teat skin condition, teat end health

Undergraduate Student Poster Competition

349 Round bale feeder design affects hay waste during horse feeding: A preliminary study. K. Cleary*, K. Martinson, and J. Wilson, *University of Minnesota, St. Paul.*

Round bales are used throughout the horse industry as a means of providing forage to horses. However, many horse owners believe that feeding round bales results in excessive hay waste and overeating. Previous research has demonstrated that using a feeder reduces hay waste, and research using beef cattle has shown that different feeder designs result in different amounts of wasted hay. Several types of equine round bale feeders have been developed to minimize waste, including a cone feeder and electronic curtain feeder. Both feeders claim to significantly reduce wasted hay. The objectives of this preliminary research were to determine hay waste, horse safety, and economic efficiency associated with three unique horse-type round bale feeders. Three round bale feeders were evaluated including a tombstone (Dura-Built), cone (Weldy Enterprises), and electronic curtain feeder (E-Z Hay Feeder). One dry lot paddock housing four adult Quarter Horse mares was used. Each horse was weighed using a weight tape at the beginning and end of the study and between each feeder. Orchardgrass round bales were fed after each bale was weighed and analyzed for quality. For each feeder type, four round bales were fed consecutively resulting in each feeder being tested for an average of 24 days. Hay that fell into the paddock surrounding the feeder was considered waste and was collected daily. This waste hay was dried and weighed. Preliminary results revealed that the tombstone, cone and curtain feeders resulted in 15%, 8%, and 9% hay waste respectively. Each horse consumed on average of 2.7% of their body weight and gained 17 kg over the course of the study. The curtain feeder resulted in excessive mane rubbing; all other feeders were considered to be horse safe. Based on hay waste, current hay price of \$100/ton, and waste without a feeder estimated at 38%, the tombstone, cone, and curtain feeders would take 5, 22, and 47 months respectively to cover the cost associated with purchasing the feeder. A future research project investigating four additional equine round bale feeders with multiple paddocks of horses is planned.

Key Words: horse, round bale feeders, economics

350 Use of ultrasound technology for the prediction of carcass yield grade of light weight, short-fed stocker cattle. S. J. Lawrence*¹, S. E. Kreider¹, J. J. Higgins¹, D. A. Blasi¹, L. Allen¹, M. E. Dikeman², M. P. Epp¹, and P. Ritter², ¹*Kansas State University, Manhattan*, ²*Cattle Performance Enhancement Company, Oakley, KS.*

Presently, most beef cattle shipped to feedlots are processed and segmented into pens based on age and weight to produce uniform carcasses at harvest. This management practice may result in some cattle being fed beyond their optimal harvest point, while prematurely harvesting some cattle that still require additional days on feed. The objective of this study was to determine the value of implementing ultrasound technology with light weight calves to predict carcass fat thickness and yield grade outcomes. Two separate groups comprising 550 crossbred weaned steer calves (182 to 227 kg) from the southeast US region were used for this study. The first group consisted of 274 head fed for 42 d before first ultrasound measurements and then placed on native grass pasture for 97 d before transported to the feedlot. The second group (276 head) was fed for 55 d before first ultrasound measurements and then shipped directly to the feedlot. Both groups were ultrasounded a second time at the feedlot approximately 60 d post arrival. At slaughter, carcass data were collected and used to fit a regression model that consisted of the variables initial fat thickness scan and estimated breed composition for the prediction of carcass fat thickness. The predicted values and the root mean square error from the regression model were used to estimate the probabilities of the various yield grades based upon the initial scan. As stocker ultrasound fat thickness increased, the probability of higher carcass yield grade values increased.

Table 1. Probabilities of carcass yield grades for crossbred steers based upon ultrasound measurement for fat thickness at stocker phase

Stocker back fat, mm	YG 1	YG 2	YG 3	YG 4	YG 5
2.0	11	52	36	<1	<1
3.0	7	47	45	<1	<1
4.0	4	40	55	1	<1
5.0	3	32	63	3	<1
6.0	1	24	70	5	<1
7.0	1	18	74	7	<1

All values expressed as percentage of predicted carcass yield grade

Key Words: ultrasound, stocker cattle, fat thickness

351 Dietary additions of Mn reduced femur strength in young pigs fed diets with supplemental vitamin D but increased strength in pigs fed diets with no supplemental vitamin D. P. Strassburg*, D. K. Schneider, and T. D. Crenshaw, *University of Wisconsin, Madison.*

In an earlier trial, pigs fed diets with 80% of Ca and P requirements displayed unexpected hypersensitive, ataxic responses during locomotion, but bone mineral content (BMC, g/pig) was equal to that of controls. In this experiment, 24 crossbred (PIC Cambrough × Line 19) pigs (10.1 + 0.2 kg) were randomly assigned to 1 of 8 diets. Treatments were arranged in a 2×2×2 factorial design. Factors included corn-SBM diets supplemented with vitamin D (VitD, 0 or 280 IU/kg diet), Ca and P at either 80% (LCA) or 120% (HCA) of dietary requirements, and supplemental Mn (0 or 20 mg/kg). Diets were fed for 28 d. Pigs were then scanned using dual-energy X-ray absorptiometry (DXA, GE Lunar Prodigy) to determine whole body BMC (g/pig). Excised femurs were scanned by DXA to determine femur BMC (g/femur), then subjected to 3-point bending tests to measure load at failure (Force, kg-mm). Differences due to main effects of VitD and Mn in pig ADG, BMC, and femur traits were not detected, but expected responses were observed due to Ca and P. Pigs fed LCA gained less, had lower whole body BMC, and lower femur BMC and Force responses than pigs fed HCA ($P < 0.03$). An interaction between VitD and Mn was detected in Force traits. In pigs fed diets with no supplemental VitD, additions of Mn increased Force, but in pigs fed diets with VitD, additions of Mn reduced femur Force. Similar trends were observed in femur and whole body BMC, but VitD × Mn interactions were not significant. A 3-way interaction of VitD, Ca, and Mn was also detected ($P < 0.02$) for Force traits. Explanations for the interaction between VitD and Mn are not available.

Table 1.

VitD, IU/kg	0	0	0	0	280	280	280	280
Ca, %	0.56	0.56	0.84	0.84	0.56	0.56	0.84	0.84
Mn, mg/kg	0	20	0	20	0	20	0	20
ADG, kg/d ^a	0.46	0.40	0.60	0.54	0.52	0.47	0.65	0.56
Pig BMC, g ^a	219	183	430	455	219	193	564	415
Femur BMC, g ^a	11.1	17.0	16.6	20.3	14.4	10.9	21.8	15.2
Force, kg-mm ^{abc}	791	1665	993	2343	887	663	2626	1186

^aLCA vs HCA, $P < 0.03$; ^bVitD × Mn, $P < 0.02$; ^cCa × VitD × Mn, $P < 0.03$.

Key Words: bone ash, manganese, vitamin D

352 Effect of residual sward height after grazing on gastrointestinal nematode parasitism in meat goats. L. M. Pezzanite*¹, M. K. Neary¹, T. K. Hutchens², K. Andries³, J. E. Tower¹, L. Snyder¹, and M. E. Einstein¹, ¹Purdue University, West Lafayette, ²University of Kentucky, Lexington, ³Kentucky State University, Frankfort.

Resistance of gastrointestinal nematodes (GIN) to anthelmintics used in goats necessitates development of alternative control or prevention programs to GIN parasitism. Grazing management that reduces animal exposure and ingestion of the infective L₃ larval stage of GIN may be one potential strategy. This study examined if residual sward heights (5.1, 10.1, and 15.2 cm) after grazing plots of primarily tall fescue naturally infected with GIN affected parasite status of Boer x Kiko goats. Grazing occurred over two seasons, early summer (G1) and late summer (G2), in 2008 and 2009. Goats were grazed for seven d on plots and then moved to drylot for 28 d. Initial doe fecal egg counts

(FEC; log transformed for analysis, arithmetic means presented), blood packed cell volume (PCV), FAMACHA eye score (1 = normal; 5 = severely anemic), BW, and BCS were similar ($P > 0.05$). The d 28 FEC (5.1 cm: 1801 ± 286 eggs/g; 10.1 cm: 2026 ± 292 eggs/g; 15.2 cm: 1423 ± 290 eggs/g) and PCV (5.1 cm: 24.5 ± 0.54%; 10.1 cm: 24.9 ± 0.54%; 15.2 cm: 25.1 ± 0.55%) across years was not different ($P > 0.05$) due to residual forage height. Season (G1 vs. G2) was significantly different ($P < 0.05$) for d 28 FEC (2852 ± 218 vs. 649 ± 253 eggs/g), PCV (19.8 ± 0.41 vs. 29.9 ± 0.47%), and FAMACHA (3.8 ± 0.1 vs. 3.1 ± 0.1) in does. Doe BW tended ($P = 0.07$) to be heavier at d 28 for the G2 (45.5 kg) period than G1 (42.95 kg). Correlations between PCV and FEC, PCV and FAMACHA, and FEC and FAMACHA for goats grazing in G1 and G2 periods were highly significant ($P < 0.001$). Correlations were positive for FEC and FAMACHA (G1: R = 0.33; G2: R = 0.43) and were negative for FEC and PCV (G1: R = -0.48; G2: R = -0.6) and PCV and FAMACHA (G1: R = -0.57; G2: R = -0.55). Results reveal no difference in GIN parasitism due to residual sward heights used in this study, but season of grazing did affect GIN status in meat goat does.

Key Words: goat, parasitism, sward height

353 Significant bone loss of the equine distal phalanges in a population of domestic horses. T. J. Calvert-Jackson* and R. M. Bowker, *Michigan State University, East Lansing.*

Long term loss in bone mass and density represents significant problem in man characterized by normal bone, but weakened strength, leading to increased risk of trabecular fractures. While bone loss is believed to be due to non-weight bearing or hormones, rebuilding by direct loading has been problematical as it does not relate to changes of bone mass. Increased exercise can increase bone mass in young, but not adults. In horses the distal phalanx is porous, making it susceptible to bone loss. The purpose of this study was to examine the distal phalanges of normal horses for evidence of bone loss. The forefeet and hind feet of horses (known age and breed) were used with feet (N=50 horses) being photographed and radiographed. The bones were then harvested, cleaned and dried prior to determining volume displacements and weight measurements and detailed surface features determined (scale 1-4). Select bones were processed for histology and mineral content. The feet were grouped into being shod or barefoot and analyzed using Student t test ($P < 0.05$). Results revealed a wide range weights (40-128 grams) of forefeet distal phalanges in contrast to hind feet (60-80 grams). Distinct regions on dorsal cortex contained areas of bone remodeling and are being examined quantitatively. Preliminary findings indicate no apparent relationship of age and bone loss in the barefooted condition but only in shod feet. These findings provide an initial basis for further examination even though osteoporosis is presently not recognized clinically as a concern in the horse's foot.

Key Words: equine, lameness, osteoporosis

354 Effect of standing estrus prior to an injection of GnRH on steroidogenic enzyme expression in luteal tissue. K. L. Gebhart*, B. L. Perry, M. G. Gonda, C. L. Wright, R. C. Bott, and G. A. Perry, *South Dakota State University, Department of Animal and Range Sciences, Brookings.*

Cows detected in estrus around the time of fixed-time AI had increased pregnancy success and progesterone concentrations. Additionally,

GnRH following onset of estrus influenced LH pulse frequency and CL formation/function. Therefore our objective was to determine steroidogenic enzyme expression within luteal tissue of cows that were or were not detected in standing estrus prior to an injection of GnRH. Cows were synchronized with the CO-Synch protocol (d -9 100 µg GnRH; d -2 25 mg PGF_{2α}; d 0 100 µg GnRH). Estrus was detected with the HeatWatch system. Location and size of the ovulatory follicle was determined on d 0 at time of GnRH by transrectal ultrasonography; blood samples were collected on d 3,4,5,7, and 9; and luteal tissue was collected on d 10 (n = 3 estrus and n = 8 no estrus) from CL originating from similar sized follicles (13.5 to 16 mm). Total cellular RNA was extracted and relative mRNA levels were determined by real-time RT-PCR and corrected for GAPDH. There was no effect of estrus on CL weight ($P = 0.83$). There was no effect of estrus by time ($P = 0.17$) or estrus ($P = 0.97$) on progesterone concentrations, but there was an effect of time ($P < 0.01$). In addition, there was no effect of estrus, follicle size, or CL weight on LH receptor expression ($P = 0.97, 0.94,$ and 0.85), StAR expression ($P = 0.87, 0.92,$ and 0.86), CYP11A1 expression ($P = 0.49, 0.27,$ and 0.99), or 3βHSD expression ($P = 0.49, 0.61,$ and 0.91). However, there was a correlation between follicle size and CL weight ($P = 0.01$; $R^2 = 0.51$); for every increase of 1 mm in follicle size, CL weight increased by 1.1 g. In addition, there was an effect of CL weight by time ($P = 0.01$) on progesterone concentrations and an effect of time ($P < 0.01$) with a tendency for an effect of CL weight ($P = 0.06$). In summary, estrus did not influence CL weight, progesterone concentrations, or expression of steroidogenic enzymes. However, as follicle size increased, CL weight increased, and CL weight influenced progesterone concentrations.

Key Words: estrus, steroidogenic enzymes, progesterone

355 Fat quality in Holstein cows fed zilpaterol HCl. J. A. Safko*, B. K. Lowe, R. O. McKeith, R. M. Pitzer, J. R. Segers, L. Stewart, M. A. Froetschel, A. M. Stelzleni, and T. D. Pringle, *University of Georgia, Athens.*

Zilpaterol HCl (ZH) is a β₂-adrenergic agonist that has been shown to improve feeding performance and carcass leanness in cattle; however, little is known about its effects on fat quality attributes. Thus, thirty-four, predominantly Holstein, cull dairy cows were used to study the effects of ZH feeding on s.c. fat quality measures. Cows arrived at the UGA Wilkins Beef Cattle Unit and were processed according to farm protocol. They were implanted with Revalar-200 and stratified by weight to a 42-d feeding trial. Cows were fed, in two replicates, a diet containing peanut hulls, soy hulls, corn gluten, and ground corn. Additionally, half of the cows received 7.5 ppm of ZH from d 19 to 39, with a 3-d withdrawal. Ultrasound data were collected on d 0, 19, and 42. At the end of the feeding period, cows were transported to the UGA meat lab and harvested, under FSIS inspection. Hot carcass weights were gathered and carcasses were chilled at -2C for 48 h. USDA grade data were collected and s.c. fat L*, a*, b* values and color scores (1 - 5) were collected in the 11th rib region. An s.c. fat sample (20 g) was removed from the same area for fatty acid analysis. Fatty acids were prepared using a FAME procedure and quantified on a GC. Data were analyzed using ANOVA, with treatment, replicate and their interaction in the model and lsmeans were generated. Fat thickness, determined ultrasonically, was not significantly different at d 0, 19, or 42, which is consistent with 12th rib fat measures (6.9 vs 5.4 mm; $P = 0.26$). Neither Hunter L*, a*, b* values ($P > 0.40$) nor subjective fat color ($P = 0.74$) were affected by treatment. For fatty acid analysis, the percentage of C14:0 was higher ($P = 0.02$) in control cows than cows

fed ZH (3.47 vs 3.00), while ZH-fed cows had a higher percentage of C18:1, *cis* 9 than control cows (42.59 vs 40.53, $P = 0.03$). Although the percentage of SFA and MUFA did not differ across treatment ($P > 0.60$), the percentage of PUFA tended to be higher ($P = 0.09$) in the control group than the ZH-fed cows. While ZH has been shown to increase lean accretion, these data suggest that it does not greatly impact s.c. fat quality in fed Holstein cows.

Key Words: market cows, fatty acids, zilpaterol

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Numbers following names refer to abstract numbers, not page numbers. The author index is created directly and automatically from the abstracts. If an author's name is typed differently on multiple abstracts, the entries in the author index will reflect these discrepancies. Efforts have been made to make this index consistent; however, error from author entry contributes to inaccuracies.

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