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SYMPOSIA AND ORAL SESSIONS

Allee Symposium: Science in Practice

1 Science shaping an industry: Past, present, future. G. L. Allee*, *University of Missouri, Columbia.*

Pork production in North America as I started my career was dominated by independent family-based, small-scale operations. Most of the swine diets were simple corn-soybean meal diets with added vitamins and minerals. Problem solving swine research was conducted at almost all of our Land Grant Universities and results were delivered by university extension programs to swine producers. This model worked very well for many years; however, this is not a workable model for our current or future pork industry that is currently dominated by large-scale firms that are tightly aligned across production and distribution chains. The present and future pork industry needs immediate answers to questions to enhance production efficiencies with studies conducted in modern production facilities using modern genetics, appropriate pen size, stocking density and a known health status. The development of new swine research models is necessary if the US is to continue to lead in problem solving swine research or this leadership role will be taken by other countries. We have been involved in a private/public partnership of research to understand the nutrient needs of modern sows during gestation and lactation and this model works well. This model (private/public partnership) allows research to be conducted, that provides answers to our current and future research needs, permits sharing of research results with relevant stakeholders and facilitates the development of young, intelligent, inquisitive minds to lead the next generation of applied researchers.

Key Words: swine, research needs, research modes

2 Vitamin D deficiency in pigs—Fad, fiction, and facts. T. D. Crenshaw* and L. A. Rortvedt, *University of Wisconsin, Madison.*

Abrupt increases in diagnosis of vitamin D deficiency have occurred in necropsies of young pigs over the past 2 to 3 years. Clinical symptoms included lameness and locomotive disorders, hypocalcemia, osteomalacia, low serum 25-OH D_3, and mortality, despite verification of adequate dietary Ca. Surprisingly, classical signs of rickets were not routinely reported. Mortality in some grower units has exceeded 40%. Concerted efforts by managers, nutritionists, clinicians, and pathologists to identify underlying reasons for abrupt increases in vitamin D deficiencies have generated numerous explanations. Creative explanations include: poor quality control in vitamin D manufacturing; improper formulation of concentrated vitamin premixes; increased inclusion (50 to 60%) of DDGS in complete diets; increased dependency on phytase to supply P and associated quality control concerns; adoption of tunnel ventilation in facilities which may preclude UV light exposure to both growing pigs and gestating sows; and changes in heat lamp exposure to baby pigs during lactation. Standard explanations such as changes in genetic lines and underlying chronic disease problems were also discussed. Each explanation has a basis consistent with classical vitamin D roles, but no evidence has been provided to vindicate any explanation. Vitamin D deficiency in young growing pigs is unexpected because deficiencies of fat soluble vitamins are difficult to induce over relatively short periods in animals fed natural ingredient diets. However, kyphosis and a 30% reduction in growth of pigs fed natural ingredient diets with no supplemental vitamin D was recently reported in a 5-wk post-weaning trial [Rortvedt et al. 2011. J. Anim. Sci. 89(E-Suppl. 1):ii]. Induction of these responses within such a short time raises concerns for vitamin D supplements in sow gestation diets and the subsequent consequences on fetal and neonatal vitamin D status. Research to define vitamin D requirements for fetal and neonatal pigs is sparse. Definitive guidelines for vitamin D fortification of sow and neonatal pig diets are needed.

Key Words: hypocalcemia, kyphosis, neonatal development, clinical diagnosis

3 China swine production: A personal observation. G. R. Stoner*, *CP Group–China Operations, Beijing, P. R. China.*

For decades, reports have been published predicting China will become a major importer of pork. Many limitations to increasing

swine production in China have been identified. The current United States Department of Agriculture (USDA) Foreign Agricultural Services (FAS) estimate of the pig crop in China for 2011 is in the region of 640 million head. This represents approximately 5.5 times the USDA 2011 pig crop estimate of 114 million head for the USA. The 2011 USDA FAS production estimate represents an approximately 33% increase in the annual pig crop in China since year 2000 compared with an approximately 13% increase in the USA pig crop over the same period. According to UDSA FAS statistics, pork imports to China have increased by nearly 750% from year 2000 through 2011. USDA FAS estimates pork imports to China in 2011 at approximately 550,000 t. The USDA estimates 2,240,000 t pork exports from the USA for 2011. Total pork imports to China correspond to 22% of total pork exports from the USA. According to USDA FAS, the estimated total pork supply in China for 2011 is 50,220,000 t, thus the 550,000 t imported represents approximately 1.1% of total pork supply in China for 2011.

Key Words: China, pig crop, pork import

4 Using science and a system-based approach to innovate a modern swine production business. B. A. Peterson*, *The Maschhoffs, Carlyle, IL.*

Modern swine production is a dynamic business that requires extensive understanding of biological and economic principles to adapt and embrace change to remain competitive on a global scale. Managing and facilitating change can be accomplished by utilizing a science based innovation process that is integrated in the business and utilizes outside partnerships with an overall focus on creating value. Innovation in a modern swine production business requires that researchable ideas come from multiple sources and cover the spectrum of basic to applied science. Prioritization of these ideas is critical to ensure that scarce resources are deployed against the concepts that have the highest potential for value creation. Discovery research can, and should be basic, translational, or applied in nature, but must be focused on creating knowledge that can be applied to technologies or management strategies that are applicable to the business. Validation research is a critical step in the innovation process and must be carried out on a larger scale, throughout the range in environments that are experienced by the pig in the production system. Implementation of the technology or strategy in the business requires disciplined change management and transparency of research results with production leaders. Finally, the results of innovation must be verified to ensure the intended impact is realized in the business. Partnership between private industry and public institutions, especially universities, can significantly enhance the effectiveness and overall value creation potential of the innovation process. The true value of the partnership is created through the shared learning that is a result of the interaction. Academia gains exposure and appreciation for practical realities in production systems, as well as the demands of highly competitive business, and production systems benefit from exposure to the creativity and high standards for scientific excellence that are fostered in an academic environment. Finally, by involving a public institution, the entire industry benefits by accessing the knowledge that is created through the partnership in the form of publications and students who will go on to become the future leaders and innovators in the industry.

Key Words: systems approach, swine production, innovation

5 Current lysine:calorie ratio recommendations and their use in diet formulation. R. D. Goodband*, M. D. Tokach, S. S. Dritz, J. M. DeRouchey, and J. L. Nelssen, *Kansas State University, Manhattan.*

The response to dietary energy and standardized ileal digestible (SID) Lys in pigs is highly variable due to the wide range in genetic capacity for lean gain, health, and environmental conditions. Furthermore, studies conducted in commercial research facilities suggest that feed intake is much lower than studies in university settings. This suggests that finishing pigs are very likely to be in an energy dependent phase of growth to heavier weights than previously estimated. As long as pigs respond to dietary energy changes, this necessitates the use of a Lys:calorie ratio. Unfortunately, over the past 10 years, only a limited number of published Lys studies for finishing pigs are in the public domain. However, they provide reasonable starting estimates on which to set Lys concentrations. Assuming a protein deposition of 150 g/d from 20 to 120 kg, adapting equations from Main et al. (2008) and the National Swine Nutrition Guide (van Heugten, 2010), the equation: g /SID Lys:Mcal = 0.000146 × (BW, kg)^2 ± 0.0377 × (BW, kg) + 4.352; describes the SID Lys:calorie ratio for barrows while; g/SID Lys:Mcal = −0.00000094 × (BW, kg)^3 + 0.000306 × (BW, kg)^2 ± 0.0435 × (BW, kg) + 4.414) describes the g SID Lys:Mcal ratio for gilts (Table 1). A second option for estimating Lys requirements uses g Lys/kg gain. A review of the literature indicates that for nursery pigs (<20 kg) require approximately19 g of SID lysine/kg of gain, whereas finishing pigs require approximately 20 g/kg of gain. With this approach, accurate growth and energy intake curves are required to generate a customized Lys:calorie ratio. As an increasing variety of feed ingredients are used, the range of dietary energy levels has expanded, increasing the need for accurate Lys:calorie ratios in diet formulation.

Table 1. SID lysine recommendations as influenced by weight

Pig wt, kg	g/kg gain	g/Mcal ME[2]	%[1,2]	g/Mcal ME[3]	%[1,3]
5	19	4.17	1.40	4.20	1.40
10	19	3.99	1.34	4.01	1.34
15	19	3.82	1.28	3.83	1.28
20	19	3.66	1.22	3.66	1.23
30	20	3.35	1.12	3.36	1.13
40	20	3.08	1.03	3.10	1.04
50	20	2.83	0.95	2.89	0.97
60	20	2.62	0.88	2.70	0.91
70	20	2.43	0.81	2.55	0.85
80	20	2.27	0.76	2.41	0.81
90	20	2.14	0.72	2.29	0.77
100	20	2.04	0.68	2.18	0.73
110	20	1.97	0.66	2.08	0.70
120	20	1.93	0.65	1.98	0.66

[1]Percentage is for a diet containing 3,350 kcal ME/kg using NRC (1998) nutrient values.
[2]Barrows.
[3]Gilts.

Key Words: calorie:lysine ratio, energy, lysine

6 Effects of reducing crude protein level and replacement with crystalline amino acids on growth performance, carcass composition, and fresh pork quality of finishing pigs fed Paylean. J. K. Apple*[1], C. V. Maxwell[1], J. W. S. Yancey[1], R. L. Payne[2], and J. Thomson[2], *[1]Department of Animal Science, University of Arkansas Division of Agriculture, Fayetteville, [2]Evonik-Degussa Corp., Kennesaw, GA.*

Crossbred pigs (n = 216) were blocked by initial BW, and, within blocks, pens of pigs (6 pigs/pen) were randomly assigned to dietary treatments where CP of finisher I, II, and III diets was: 1) 16.04, 14.55, and 16.23%, respectively; 2) 14.76, 13.48, and 15.27%, respectively; 3) 14.26, 12.78, and 14.28%, respectively; or 4) 12.65, 12.38, 13.32%, respectively. All finisher III diets included 10 mg/kg of Paylean and an SID Lys:ME ratio of 2.79 g/Mcal. At slaughter, HCW and FOM data were recorded, and a subsample of bone-in hams (3/pen) and loins (2/pen) were transported to the University of Arkansas. Hams were knife-dissected into lean, fat, and bone, and 2.5-cm-thick chops from the semimembranosus (SM) and the LM were used to measure fresh pork quality. Both ADG and G:F decreased linearly ($P \leq 0.053$) as CP decreased in finisher I diets, whereas ADFI was reduced linearly ($P = 0.009$) in response to decreasing CP in finisher II diets. When RAC was included in the finisher III diets, ADFI and BW decreased linearly ($P \leq 0.027$) with decreasing CP. Across the entire finishing period, ADG and ADFI decreased linearly ($P \leq 0.012$) in response to reductions in dietary CP. Conversely, reducing CP in finisher diets did not ($P \geq 0.329$) affect fat depth, LM depth, or calculated fat-free lean yield, and dietary CP content did not ($P \geq 0.263$) alter the composition of fresh hams. There was no effect of dietary CP on the visual and instrumental color, firmness, or drip loss percentage of the LM ($P \geq 0.179$) or SM ($P \geq 0.120$). However, there were linear increases in LM marbling scores ($P = 0.020$) and intramuscular fat content ($P = 0.032$) as CP was reduced in the finisher diets. Although reducing dietary CP decreased ADG and ADFI by approximately 6.1 and 4.9%, respectively, carcass composition was not affected. Reducing dietary CP, while meeting the SID requirements for Lys, Thr, Trp, Met, Ile, and Val with crystalline AA, did not affect pork color or water-holding capacity and actually increased the intramuscular fat content of the LM.

Key Words: crude protein level, intramuscular fat content, pork quality, swine

7 How to feed pigs without whole grains and soybean meal. H. M. J. van Hees*[1], P. J. L. Ramaekers[1], and A. Pharazyn[2], *[1]Nutreco Swine Research Centre, St Anthonis, the Netherlands, [2]Nutreco Canada Agresearch, Guelph, Ontario, Canada.*

Worldwide, barley, wheat and corn are important constituents of pig diets, not only for energy (starch) but as substantial contributors to the supply of dietary amino acids. Soybean meal, with its amino acids counterbalances the deficiencies of cereal protein, particularly lysine. The 2008 and 2011 surge in cereal grain prices demonstrate that pig farmers will face more volatile and higher price levels (Rabobank, 2005). Currently, almost 3 quarters of the EU's protein requirements for animal feed needs to be imported. The EU's dependency on soy imports will remain high despite increased rapeseed production for biofuel and initiatives to increase protein crops. Also, a foreseen lift of the ban on meat and bone meal will only slightly alleviate this. In the longer term, the requirements needed in 2050 to feed the world

population and to provide renewable fuel sources, will make whole cereals less available for livestock. Moreover, feeding pigs with minimal soybean meal (SBM) is not a hypothetical scenario. There is a discussion in the Netherlands on how to increase the use of feedstuffs produced within the EU. In western Canada, pig diets use minimal levels of SBM as peas, canola meal make significant contributions to dietary amino acids. In central Canada, significant use of co-products from the food and ethanol industry are used as dietary ingredients. This paper discusses the nutritional alternatives to whole grains and SBM, focusing on co-products from cereal processing, and meals from pulses and other oilseeds. In addition, low whole grains and SBM pig diets can be expected to contain more fiber, added fat and synthetic amino acids. To account for the expected variability, proper estimation of the nutritional value, stringent quality control (e.g., over-processing) and formulation on NE and SID is required. This warrants further investigation to quantify the impact of fiber and anti-nutritional factors on pig protein requirements. Moreover, new technologies may become available to upgrade low quality feedstuffs.

Key Words: whole grains, soybean meal, alternative proteins, amino acids

8 Effect of a branched-chain amino acid imbalanced supply on voluntary feed intake and the postprandial plasma kinetics of branched-chain amino acids in piglets. M. Gloaguen*[1,3], N. Le Floc'h[1,2], E. Corrent[3], Y. Primot[3], and J. van Milgen[1,2], *[1]INRA, UMR1079, SENAH, Saint-Gilles, France, [2]Agrocampus Ouest Rennes, UMR 1079, SENAH, Rennes, France, [3]Ajinomoto Eurolysine s.a.s., Paris, France.*

When a diet deficient in valine is offered to piglets, feed intake is typically reduced. This effect is aggravated when dietary leucine is provided in excess. The physiological mechanism involved in the rejection of a diet imbalanced in branched-chain amino acids (BCAA) has not been clearly identified. The time course of sensing an amino acid deficiency can help to identify the mechanisms responsible for the aversive response. We therefore determined if the pig was able to reject a balanced diet one hour after ingestion of a (small) test meal deficient or not in standardized ileal digestible (SID) Val:Lys (52 vs 70% SID Val:Lys). Diets were based on wheat (41%), barley (41%) and an excess supply of leucine (165% SID Leu:Lys) was achieved by the use of corn gluten meal (8%). Ingestion of the test meal deficient in valine resulted in a 16% reduction in feed intake of the balanced diet ($P = 0.06$; n = 12), indicating that the signal to reduce feed intake occurred within 1 h. It is possible that the plasma concentration of the limiting amino acid serves as a signal for the dietary amino acid deficiency. We therefore determined the postprandial kinetics of plasma concentrations of BCAA after ingestion of a test meal deficient or not in valine in 4 piglets. When the diet was deficient in valine, the peak of valine concentration occurred earlier (29 ± 4 vs. 52 ± 5 min; $P < 0.01$) in combination with a lower peak concentration (130 vs. 180 µmol/L). The valine deficiency had no effect on plasma leucine and isoleucine kinetics. It appears that the piglet is able to detect a BCAA imbalance within 1 h. The plasma concentration of valine or its concentration relative to the other BCAA during the postprandial period may act as a signal indicating the amino acid deficiency.

Key Words: branched-chain amino acids, feed intake, pigs

9 Nutritional aspects of animal health and oxidative stress. T. E. Burkey*[1], T. E. Weber[2], and N. K. Gabler[3], *[1]University of Nebraska, Lincoln, [2]USDA-ARS, Ames, IA, [3]Iowa State University, Ames.*

Oxidative stress involves the harmful generation of free radicals resulting in damage to cellular lipids, proteins, or DNA. The resultant biological damage inhibits normal cellular function and is caused by an overproduction of reactive oxygen species (ROS) and concomitant reduction of enzymatic and non-enzymatic antioxidants. The major source of mammalian ROS is an unavoidable byproduct of cellular respiration and mitochondrial electron leakage. A second major source of ROS is associated with inflammatory responses. Therefore, the relationship between ROS and animal health and disease is extremely complex. In fact, oxidative stress has a significant role in the pathogenesis of disorders/diseases relevant to animal health. Consequently, dietary interventions targeting oxidative stress amelioration have been proposed and supplementation of antioxidants may have positive effects on markers of oxidative damage. Reducing oxidative damage may also improve livestock feed efficiency. However, a lack of knowledge with respect to the mechanisms (immunological, physiologic, and metabolic) underlying nutrient by health interactions is a current roadblock in the development of management strategies to optimize pig performance in the face of disease challenge.

Key Words: animal health, nutrition, oxidative stress

10 Influence of deoxynivalenol and L-Trp supplementation on weight gain, feed intake, and immune responses of nursery pigs. Y. B. Shen*, A. C. Chaytor, and S. W. Kim, *North Carolina State University, Raleigh.*

Studies have shown that administration of deoxynivalenol (DON) increases the catabolism of hypothalamic serotonin. Supplementation of L-Trp as a precursor of serotonin may benefit pigs with DON exposure. This study was to evaluate the effects of DON exposure and L-Trp supplementation on weight gain, feed intake, and immune response of nursery pigs. One hundred 20 pigs (10.36 ± 0.10 kg) at 6 wk of age were used in a randomized complete block design study. Pigs were randomly allotted to 4 dietary treatments based on a 2 × 2 factorial arrangement, with DON contamination (0.0 or 3.0 mg/kg diet) and L-Trp supplementation (0.0 or 8.0 g/kg diet) as 2 main factors. Each treatment had 10 pens with 3 pigs per pen. Pigs were fed the assigned diets for 20 d. Body weight and feed intake were measured on d 5, 9, 15, and 20, and plasma was collected on d 9 and 20 for measurement of immune parameters. During the entire study, pigs fed the diets contaminated with DON had decreased ADG (436 vs. 484 g; $P < 0.01$), ADFI (761 vs. 818 g; $P < 0.01$), and G:F (0.574 vs. 0.593; $P = 0.04$) compared with pigs fed the uncontaminated diets. Supplementation of L-Trp had little effect on growth. There was an interaction for ADFI showing that ADFI (837 vs. 799 g; $P = 0.03$) of pigs was increased by L-Trp supplementation without DON, whereas ADFI (777 vs. 745 g; $P = 0.03$) was decreased by L-Trp supplementation with DON. Dietary DON decreased plasma IgG concentration (4.75 vs. 5.84 mg/mL; $P < 0.001$) on d 9 but tended to increase plasma IgA (429 vs. 345 ug/mL; $P = 0.066$) on d 19. Pigs fed the diet with L-Trp supplementation had decreased plasma IgG ($P = 0.03$) and tumor necrosis factor-α (TNF-α; $P = 0.02$) on d 9, and reduced plasma IgM ($P = 0.02$) on d 19 compared with pigs fed the diets without L-Trp supplementation. Collectively, DON reduced ADG of pigs in association with a decreased ADFI, reduced G:F and increased IgA concentration. Although L-Trp supplementation reduced immune parameters of pigs, it did not have beneficial effect for pigs under DON exposure.

Key Words: deoxynivalenol, immune response, pigs, tryptophan

11 The effects of supplemental nucleotides on growth and health of piglets. A. C. Chaytor* and S. W. Kim, *North Carolina State University, Raleigh.*

This study was conducted to determine the effect of supplemental nucleotides in nursery pigs for enhanced growth and health after weaning. Piglets (n = 120, 7.26 ± 0.09 kg BW) were weaned at 22 ± 0.1 d, and were randomly assigned to 4 treatments (10 replicates, 3 pigs per pen). Post weaning, a standard phase 1 diet (3.3 Mcal ME/kg; 22.4 g CP/kg; 1.34 g Lys/kg) was fed for 8 d. Diets were supplemented with 0.0, 0.2, 0.5, or 1.0 g/kg of a nucleotide product containing 48% inosine monophosphate (CJ Bio, Korea). After d 8, pigs were given a phase 2 diet (3.3 Mcal ME/kg; 21.3 g CP/kg; 1.20 g Lys/kg) for 21 d with the same dietary treatments. Pigs were given free access to feed and water. Body weight and feed intake were measured weekly, and blood samples collected at the end of each phase to measure immunological parameters IgG, IgM, IgA, and tumor necrosis factor α (TNFα). Oxidative DNA damage was measured by 8-hydroxy-deoxyguanosine (8-OHdG), and fecal scores were measured to determine the severity of post weaning diarrhea. The ADG (0.27, 0.26, 0.28, 0.30 kg, respectively) and ADFI (0.41, 0.43, 0.44, 0.48 kg) were increased linearly ($P = 0.049$ and $P < 0.001$) as dietary supplementation of nucleotides increased. Gain-to-feed ratio was not affected ($P > 0.10$) by treatment. Plasma IgA (0.63, 0.48, 0.48, 0.63 mg/mL) was changed quadratically ($P = 0.020$) with the smallest concentrations at 0.2 and 0.5 g/kg nucleotide supplementation. Concentration of IgM (1.55, 1.95, 1.39, 1.80 mg/mL) was affected cubically ($P = 0.038$) with the lowest concentrations at 0.5 g/kg nucleotide supplementation. Plasma TNFα (126.7, 99.6, 98.2, 85.6 pg/mL) was decreased linearly ($P = 0.045$), and 8-OHdG (0.54, 0.40, 0.36, 0.41 ng/mL) tended to decrease linearly ($P = 0.079$) as dietary supplementation of nucleotides increased. On d 9, fecal scores tended to change quadratically ($P = 0.088$) with the lowest score at 0.5 g/kg nucleotides. Overall, supplementation of 0.5 g/kg nucleotides may provide the most benefit to young pigs by enhancing daily gain, improving feed intake, and reducing inflammation and oxidative damage.

Key Words: growth, immune response, nucleotides, pigs

Graduate Student Oral Competition–MS

12 The effects of orally supplemented vitamin D_3 on serum 25(OH)D_3 concentrations and growth of pre-weaning and nursery pigs. J. R. Flohr*[1], M. D. Tokach[1], S. S. Dritz[1], S. C. Henry[2], M. L. Potter[2], L. M. Tokach[2], J. P. Goff[3], R. L. Horst[4], J. C. Nietfeld[1], D. M. Madson[3], S. M. Ensley[3], R. D. Goodband[1], J. L. Nelssen[1], J. R. Bergstrom[1], J. M. DeRouchey[1], *[1]Kansas State University, Manhattan, [2]Abilene Animal Hospital, Abilene, KS, [3]Iowa State University, Ames, [4]Heartland Assays Inc., Ames, IA.*

A total of 270 pigs from 29 litters (PIC 327 × 1050, initially 1 to 2 d of age) were used in a 52 d study to determine the effects of oral vitamin D_3 supplementation on growth performance, serum 25(OH)D_3, and bone mineralization of pigs pre- and post-weaning. After farrowing, pigs were weighed and allotted into matched sets of 3 in a randomized complete block design, and were allotted to 1 of 3 treatments. Pigs were initially weighed over 2 different days (d 0 or 2), allowing pigs to be placed on test 1 or 2 d after birth. Pigs received a single oral dose of 1 mL peanut oil without vitamin D_3 (control), or 1 mL peanut oil with 40,000 IU, or 80,000 IU vitamin D_3. One matched set per litter, which was the closest to the average weight of the litter, was bled before dosing and on d 10, 20, 30, and 52 to measure 25(OH)D_3 concentrations. On d 20, pigs were weaned, and allotted by treatment to pens in the nursery and fed common diets from d 20 to 52.Vitamin D_3 was included in sow and nursery diets at 1,378 IU/kg. Bone ash and histology were determined on d 19 (6 pigs/treatment) and on d 35 (6 control and 6–80,000 IU pigs). Overall, no differences were observed in growth performance ($P > 0.30$), but pigs dosed with vitamin D_3 were 132 g and 227 g heavier at the end of the lactation and nursery phases respectively. No differences were found for bone ash concentration ($P > 0.09$) and no pathologic lesions were identified by microscopic evaluation of bone. Increasing oral vitamin D_3 increased serum 25(OH)D_3 concentrations on d 10 and 20 (quadratic, $P < 0.01$), and on d 30 (linear, $P < 0.01$). An oral dose of vitamin D_3 after birth increased serum 25(OH)D_3 through 30 d of age, but did not influence pig performance, bone ash, or bone histological measurements.

Table 1.

		Vitamin D_3				
Item	Control	40,000 IU	80,000 IU	SEM	Linear	Quadratic
BW, kg						
d 20	5.91	6.04	6.05	0.18	0.44	0.69
d 52	17.80	18.02	18.02	0.36	0.65	0.79
Serum 25(OH)D_3, ng/mL						
d 2	3.6	3.5	3.6	1.2	0.99	0.99
d 10	14.7	57.3	68.5	1.2	< 0.01	< 0.01
d 20	8.0	28.1	35.8	1.2	< 0.01	< 0.01
d 30	10.4	17.8	22.5	1.2	< 0.01	0.36
d 52	13.9	15.0	15.4	1.2	0.36	0.82
Bone Ash[1], %						
d 19	35.5	32.6	30.8	2.0	0.09	0.82
d 35	31.5	N/A	33.0	2.0	0.55	N/A

[1]Means represent inorganic ash % of sampled ribs.

Key Words: 25(OH)D_3, growth, nursery pig, vitamin D

13 Hepatic mitochondrial efficiency in lines of mice differing in feed intake. T. W. Murphy*[1], J. M. McDonald[2], and M. K. Nielsen[1], *[1]University of Nebraska, Lincoln, [2]Newsham Choice Genetics, West Des Moines, IA.*

Selection was practiced for high (MH) and low (ML) heat loss using direct calorimetry to create lines of mice differing in feed intake per unit BW (FI/BW). Selection occurred for both criteria in each of 3 replications (R); an unselected control (MC) was also maintained in each replicate. A total of 25 generations of selection was practiced; the 9 lines are presently maintained without selection. As a percentage of MC, mice of MH and ML lines differed in heat loss and FI/BW by 56 and 34%, respectively, when selection ceased. The 155 male mice measured in the present study came from R1-R3 and multiple generations. The purpose of this study was to determine hepatic mitochondrial efficiency in mice at maintenance across the genetic lines. Additionally, line comparisons of BW, FI/BW, liver weight per BW (LW/BW), and body composition were analyzed. Following measurement of FI and BW over a 3-wk period, mice were euthanized, and their livers were extracted and weighed. Livers were homogenized and mitochondria were isolated in buffer for measurement of oxygen consumption, and hence mitochondrial activity, using a Clark-type oxygen electrode. There were no line differences ($P > 0.20$) in oxygen consumption (μmol O_2/min) during states 2 or 4 of respiration, but mitochondria of ML mice tended to respire at a greater rate ($P < 0.06$) than that of MH mice during state 3. With this difference, mitochondria of ML mice expressed greater ($P < 0.02$) respiratory control ratio (RCR = state 3/state 4) by 35% than that for MH mice, revealing greater degree of uncoupling, thus less efficient electron transport in MH mice. There were no line differences ($P > 0.25$) in ADP:Oxygen ratio. There was no difference in BW between MH and ML mice ($P > 0.25$), however MC mice were heavier ($P < 0.03$). Difference in FI/BW ($P < 0.001$) was large with MH mice consuming 38% more than ML mice. No line differences in LW/BW were found. Selection had an effect on fat percentage ($P < 0.05$) with ML mice being 26% fatter than MH mice. State 3 respiration rate and RCR differed between mice of MH and ML lines as expected based on the line differences in feed intake, however LW/BW did not.

Key Words: mice, mitochondria, feed intake

14 Dietary cation-anion difference alters feed intake of group housed replacement gilts. S. J. Gasca*[1], A. E. Schumacher[1], J. P. Holt[1], P. M. Walker[1], and R. Hall[2], *[1]Illinois State University, Normal, [2]Animal Feed and Nutrition, Franklin, IN.*

Group housing for gestating sows is becoming increasingly prevalent, necessitating the development of efficient and easily-managed group feeding systems. The use of self-feeders could be an ideal, low cost, low maintenance option for producers utilizing group-housed gestation systems; however, over-consumption of feed may be a problem. Dietary Cation-Anion Difference (DCAD) previously has been shown to reduce feed intake. This study observed the effects of DCAD on feed intake, nutrient digestibility, BW, backfat, urine pH and blood pH changes of group housed replacement gilts. A 135-d study was designed consisting of 3 trials involving 30, 6 to 9 mo old gilts/trial, to assess the effects of DCAD implementation in the diets of replacement gilts. DCAD was implemented in treatment diets consisting of one of 3 levels (mEq/kg diet): 50 (Control), −225 and −450. Gilts were blocked by BW and randomly assigned within block to treatment pens. Diets were randomly assigned to treatment pens (2 pens/diet) containing 5 gilts/pen. Feed and fecal samples were collected and analyzed

for DM, N and energy digestibility. With decreasing DCAD, ADFI decreased linearly ($P \leq 0.05$). No significant differences were observed regarding BW, BW gain or G:F for either 50 or −225; however, −450 resulted in lower ($P \leq 0.05$) BW, BW gain and G:F. No significant differences between treatments existed for DM and energy digestibility, or blood pH. Urine pH decreased ($P \leq 0.05$) as the DCAD within the diet decreased. Nitrogen digestibility was higher ($P \leq 0.05$) for −225 and −450, than 50. The results of this study indicate that implementing DCAD in the diets of group housed replacement gilts may be an effective method of limiting ADFI.

Key Words: group housing, sow self feeding, dietary cation-anion difference

15 The effect of myostatin genotype on body temperature during extreme temperature events. J. T. Howard*, M. K. Nielsen, T. Mader, and M. L. Spangler, *University of Nebraska, Lincoln.*

Extreme heat and cold events can create physiologic changes as cattle attempt to cope with temperature related stress. However, the genetic background of animals can influence their response to these events. The objective of the experiment was to evaluate the effect of the myostatin genotype (MG) on body temperature. Two groups of heifers (n = 120) and 2 groups of steers (n = 119), both crossbred, with either 0, 1, or 2 copies for the MG were placed in a feedlot over 2 summers (2010 and 2011) and 2 winters (2010–2011 and 2011–2012). Tympanic and Vaginal temperature (C°) logging devices were placed in the steers or heifers, respectively, for 5 d during times of anticipated heat and cold stress. The mean (±SD) of the summer and winter stress events were 24.4 (±4.64) and −3.95 (±12.16), respectively. A Fourier series transformation was used to describe a diurnal cyclical pattern. Analysis was done with temperature as the dependent variable and day, MG, and Fourier series cycles as fixed effects and animal as a random effect. A 24-h and 12-h (Model 1) cycle described the cyclical pattern for most environments, but a 24-h, 16-h, 12-h, and 8-h (Model 2) cycle was more effective at describing the extreme cold stress cyclical patterns. A MG interaction with cycle length was significant for at least the 24-h cycle ($P < 0.0275$) for both Model 1 and 2. The animal variance and repeatability across each group and stress event ranged from 0.035 to 0.18 and 0.15 to 0.64, respectively. The Fourier series fitted effectively describes the body temperature of cattle in the current study. The interaction of the MG and components of the Fourier series suggests that a genotype, represented by myostatin, by environment interaction exists for body temperature. More work in this area needs to be done to determine if a function of body temperature could be a useful physiological indicator of economically relevant traits and to determine the genetic component of the indicator trait identified.

Key Words: beef cattle, body temperature, myostatin

16 Effects of lowering dietary NDF levels prior to marketing on finishing pig growth performance, carcass characteristics, carcass fat quality, and intestinal weights. M. D. Asmus*, J. M. DeRouchey, J. L. Nelssen, M. D. Tokach, S. S. Dritz, R. D. Goodband, and T. A. Houser, *Kansas State University, Manhattan.*

A total of 264 pigs (41 kg BW) were used in a 90-d study to determine the effects of feeding high NDF diets and their withdrawal time on growth performance, carcass characteristics, fat quality, and intestinal weights of finishing pigs. Pens were allotted to 1 of 6 treatments (6 pens/treatment). Treatments were arranged in a 2 × 2 plus 2 factorial with the main effects of withdrawal time (23 or 47 d) and NDF level fed during the withdrawal (low or medium). Controls were a corn-soybean meal diet or diet with 30% DDGS and 19% wheat middlings with no withdrawal. The NDF levels were 9.3, 14.2, and 19.0% in the low, medium, and high NDF diets. Increasing withdrawal duration decreased overall ADFI (linear, $P < 0.03$) and improved G:F (linear, $P < 0.004$); however, ADG was not affected. Withdrawing the high-NDF diet for the last 23 d did not influence ($P > 0.61$) growth performance. Withdrawing the high-NDF diet improved ($P < 0.004$) carcass yield and decreased (linear, $P < 0.01$) large intestine weights with a greater response ($P < 0.04$) when the low NDF diet was fed during the withdrawal. Increasing withdrawal time from 23 to 47 d did not further improve yield ($P = 0.11$) or decrease ($P = 0.20$) large-intestine weights. Jowl fat iodine value (IV) decreased (linear, $P < 0.01$) as withdrawal time increased and was lower ($P < 0.001$) when the low-NDF instead of medium-NDF diet was fed. Increasing the duration that the low-NDF diet was fed increased ($P < 0.01$) backfat depth and tended ($P < 0.11$) to decrease percentage lean. Withdrawing pigs from a high-NDF diet before market improved G:F, carcass yield, IV, and reduced large intestine weight; however, the optimal length of withdrawal depends on the response criteria targeted.

Table 1

Treatment:	1	2	3	4	5	6	
d 0 to 43:	Low	High	High	High	High	High	
d 43 to 67:	Low	Low	Med	High	High	High	
Item d 67 to 90:	Low	Low	Med	Low	Med	High	SEM
ADG, kg	0.89	0.90	0.91	0.90	0.89	0.89	0.011
G:F	0.35	0.34	0.34	0.33	0.33	0.33	0.004
Final BW, kg	120.6	122.1	122.8	121.9	121.5	121.6	1.403
Carcass yield, %	73.2	72.9	71.6	73.0	72.4	71.7	0.265
HCW, kg	88.3	89.0	88.0	88.9	88.0	87.0	1.154
Backfat depth, mm[1]	18.8	18.4	17.5	18.3	18.9	16.8	0.448
Lean, %[a]	53.0	53.4	53.6	53.3	52.7	54.0	0.311
Jowl IV	68.4	70.6	75.8	74.9	76.6	78.5	0.942

[1]Adjusted to a common HCW.

Key Words: DDGS, NDF, wheat middlings, withdrawal

17 Equine grazing preference and persistence of cool-season grasses. E. Allen*, C. Sheaffer, and K. Martinson, *University of Minnesota, St. Paul.*

The objective was to evaluate horse grazing preference and persistence of 11 cool-season grasses. Research was conducted during 2010 and 2011 in St. Paul, Minnesota. The experimental design was a randomized complete block with 4 replications. Grasses included tall fescue (*Schedonorus phoenix*), meadow fescue (*Festuca pratensis*), quackgrass (*Elymus repens*), smooth bromegrass (*Bromus inermis*), meadow bromegrass (*Bromus biebersteinii*), reed canarygrass (*Phalaris arundinacea*), perennial ryegrass (*Lolium perenne*), timothy (*Phleum pretense*), Kentucky bluegrass (*Poa pratensis*), creeping foxtail (*Alopecurus arundinaceaus*), and orchardgrass (*Dactylis glomerata*). Four adult horses were grazed for 8 h each day for 2 consecutive days each month from May to October in 2010 and May to September in 2011. Ground cover before grazing was measured between 0 (no ground cover) and 100 (100% ground cover) to determine persistence. Grass removal was visually assessed after grazing on a scale of 0 (no grazing) to 100 (100% grazed) to determine preference. Data were analyzed using PROC MIXED and ANOVA procedures of SAS. Results differed between years ($P < 0.01$) and are presented as season-long

means. Timothy and Kentucky bluegrass were most preferred ($P < 0.05$) with removals over 70 and 60% in 2010 and 2011, respectively. Other preferred grasses included quackgrass in 2010 and perennial ryegrass in 2011. Orchardgrass, creeping foxtail and meadow bromegrass were least preferred ($P < 0.05$) with removal less than 48 and 43% in 2010 and 2011, respectively. Orchardgrass was most persistent ($P < 0.05$) with 77 and 80% ground cover in 2010 and 2011, respectively. Other persistent grasses included tall and meadow fescue in 2010, and perennial ryegrass and Kentucky bluegrass in 2011. Creeping foxtail was the least persistent grass ($P < 0.05$) with less than 68 and 60% ground cover in 2010 and 2011, respectively. Other grasses that did not persist include timothy in 2010, and reed canarygrass and bromegrasses in 2011. Planting mixtures of Kentucky bluegrass, orchardgrass, perennial ryegrass, and fescues should achieve a balance of horse preference and forage persistence.

Key Words: horse, preference, cool-season grasses, persistence

18 Effect of inclusion of a *Saccharomyces cerevisiae* fermentation product in beef cattle feedlot diets with two different sulfur concentrations on nutrient metabolism. D. M. Paulus*[1], J. M. Kelzer[1], M. V. Fossa[1], C. Belknap[2], G. I. Crawford[1], and A. DiCostanzo[1], *[1]University of Minnesota, St. Paul, [2]Diamond V, Cedar Rapids, IA.*

Thirty-two Angus steers (222 ± 48 kg initial BW) were arranged in a randomized complete block design with a 2 × 2 factorial treatment arrangement, resulting in 8 replications per treatment. Treatments contained low (0.25%; LS) or high (0.50%; HS) dietary S concentrations with (XP) or without (NXP) *Saccharomyces cerevisiae* fermentation product (56 g/head daily). Basal diets contained 46% dry-rolled corn, 33% dried distillers grains, 14% haylage, and 7% supplement. Diets contained 16% CP and 1.37 Mcal/kg NEg. After a 22 d adaption period, fecal, urine, and dietary collections occurred for 4 d. On d 18 of each of 4 collection periods cattle were injected with *Mannheimia haemolytica* type A1 to stimulate a stress response. Blood samples were collected 0, 24, 72, and 168 h post-injection and were analyzed for haptoglobin and ceruloplasmin concentrations. Intake and digestion of OM were not affected ($P > 0.20$) by treatment, and averaged 4.33 kg/d and 82.4%, respectively. Fecal N was greater ($P = 0.02$) for LS treatments than HS treatments. High S treatments increased ($P < 0.01$) Zn consumption, fecal Zn, total Zn excretion, and Zn retention compared with LS treatments. The HS treatments increased ($P < 0.03$) urinary Ca excretion and P retention compared with LS treatments. The LS, XP treatment had the greatest ($P = 0.03$) fecal Ca loss, while the HS, XP treatment had the lowest. Animals consuming the HS, NXP treatment had greater ($P = 0.03$) total Ca excretion and animals consuming the LS, NXP treatment had the lowest. Animals consuming the LS treatments excreted more ($P = 0.04$) fecal energy than HS treatment animals. No differences were observed ($P > 0.11$) for blood haptoglobin and ceruloplasmin concentrations. These results suggest that while dietary S can significantly affect mineral and energy metabolism, a significant interaction exists between dietary addition of XP and dietary S concentration on Ca metabolism.

Key Words: feedlot cattle, sulfur, *Saccharomyces cerevisiae*

19 Video imaging for real-time performance monitoring of growing-finishing pigs. J. E. Love*[1], J. Rheaume[2], J. Squire[2], and C. F. M. de Lange[1], *[1]University of Guelph, Guelph, ON, Canada, [2]Wallenstein Feed and Supply Ltd., Wallenstein, ON, Canada.*

Knowledge of daily growth rates of pigs would allow producers to optimize feeding programs and marketing practices. Visual image analysis (VIA) uses aerial-view images of animals to determine body surface dimensions and may be used for real-time monitoring of pig growth. The objectives were to assess the ability of Qscan, a European VIA system, to accurately estimate: (1) live body weight (BW) of individual pigs, and (2) mean BW for groups of growing pigs. Pigs were monitored over a 6 week period from 50 to 92 kg BW in a 2x2 factorial design, allowing assessment of the interactive effects of gender (barrows vs gilts) and feeding ractopamine (0 vs 5 ppm; fed approximately 3 weeks pre-slaughter) on Qscan accuracy. Three pens of 8 pigs each were assigned per gender and ractopamine level. Pens were continuously monitored using Qscan and pigs were weighed individually at weekly intervals using a conventional scale. Once calibrated for initial BW, Qscan generates estimates of mean pen BW. Images from individual pigs were identified manually for wk 1 and 6. Based on measurements on individual pigs, there was no difference ($P > 0.10$) between mean actual and Qscan estimated BW; there was no bias due to gender or treatment ($P > 0.10$). Actual (scale) and Qscan estimated mean pen BW differed in wk 3 only ($P < 0.05$). The accuracy of Qscan differs between genders, with interactions between gender and methods for determining BW occurring in wk 2 and 3 ($P < 0.05$). Throughout the study, the difference between actual and Qscan estimated mean pen BW was less than 1.46 kg for gilts ($P > 0.10$). On average Qscan overestimated mean pen BW of barrows by 3.51 kg for wk 1 to 3 ($P < 0.05$) and wk 4 ($P > 0.10$), but was within 0.45 kg of actual mean pen BW for wk 5 and 6 ($P > 0.10$). Variation in the number of weight measurements of individual pigs to the total number of images per pen contributed to the discrepancy between Qscan estimated and actual pen mean BW. Separate algorithms may be required to account for gender effects on relationships between video images and actual BW.

Key Words: growth, performance monitoring, pigs

20 Thermoregulation in different parity sows in forced air (FA) and evaporatively cooled (EC) farrowing rooms. W. R. Martin*, T. J. Safranski, D. E. Spiers, and M. C. Lucy, *University of Missouri, Columbia.*

Previous trials showed that first parity (P1) sows were more sensitive to heat stress during lactation than multiparous (MP) sows. The objective was to determine the effect of FA and EC farrowing rooms on thermal response of P1 and MP sows during summer 2011. Sows were assigned to treatment (trt; FA, n = 14 [4 P1 and 10 MP] or EC, n = 14 [4 P1 and 10 MP]) and entered the rooms 10 d before farrowing (d 0). Rectal temperature (RT, °C), shoulder temperature (ST, °C) and respiration rate (RR, breaths per minute, bpm) were collected thrice weekly (Monday, Wednesday, and Friday) in the morning (AM; 0900h) and afternoon (PM; 1500h). Outdoor high and low Ta (ambient temperature, °C) during the trial were 31.4 ± 3.6 and 20.5 ± 3.2. Daily high and low Ta were 30.2 ± 2.8 and 23.9 ± 2.0 within FA and 28.7 ± 1.4 and 24.5 ± 1.3 within EC. For all sows, RT increased ($P < 0.001$) after farrowing (38.2 ± 0.1 on d −2 to 39.2 ± 0.1 on d 2) and remained elevated. P1 and MP sows were similar for RT before farrowing (38.4 ± 0.1 and 38.2 ± 0.1, respectively), but after farrowing RT was greater in P1 sows [39.4 ± 0.1 and 39.0 ± 0.1, respectively; Parity by d of lactation (dol), $P < 0.05$]. There was an effect of trt by dol ($P < 0.05$) for RR; sows in FA and EC were similar for RR on d −2 (63 ± 6 and 62 ± 6) but FA sows had greater RR by d 18 (77 ± 6 and 66 ± 6, respectively). There was an effect of parity by time ($P < 0.005$) for RR; P1 sows had a greater increase in RR from AM to PM (53 ± 4 to 71 ± 4) compared with MP sows (61 ± 3 to 65 ± 3). For all

sows, ST increased ($P < 0.001$) after farrowing (35.8 ± 0.2 on d −2 to 36.6 ± 0.2 on d 2) and remained elevated. There was an effect of parity by time ($P < 0.06$) for ST; P1 sows had a greater increase in ST from AM to PM (36.2 ± 0.2 to 37.0 ± 0.2) compared with MP sows (36.3 ± 0.1 to 36.6 ± 0.1). The thermal response of P1 sows is different from MP sows during the summer. P1 sows had greater RT during lactation and underwent a greater change in RR and ST during the day. Trt did not alleviate the thermal response to parity or lactation. Supported by Grant 2007-55203-18261 from the USDA NIFA.

Key Words: sow, heat stress, thermoregulation

21 Effects of alternate day feeding of dried distillers grains plus solubles on intake, ruminal pH and VFA concentrations, and total-tract digestibility in forage-fed steers. S. I. Klein*[1], A. M. Meyer[2], Q. P. Larson[1], M. L. Bauer[1], J. S. Caton[1], and C. R. Dahlen[1], *[1]Department of Animal Sciences, North Dakota State University, Fargo, [2]Department of Animal Sciences, University of Wyoming, Laramie.*

The objective of this experiment was to examine effects of feeding either dried distillers grains plus solubles (DDGS) or grass hay on alternate days on intake, ruminal fermentation, and digestibility in forage-fed steers. Four ruminally, duodenally, and ileally cannulated Holstein steers (448.8 ± 7.3 kg BW) received each of 4 dietary treatments in a 4 × 4 Latin square: 1) hay only (CON); 2) hay and 0.4% BW DDGS daily (DG7); 3) hay daily and 0.8% BW DDGS on alternate days (DG3); and 4) hay only or 0.8% DDGS only on alternate days (DGA). Treatment periods consisted of 13 d of adaptation and 8 d of collecting ruminal pH, ruminal fluid, and digesta. Supplemented d (SUP) and non-supplemented d (NSUP) were defined as days when DG3 and DGA did or did not receive DDGS, respectively. Over the entire collection period DMI was decreased ($P < 0.01$) for DGA (13.18 ± 0.68 kg/d) compared with CON (16.00 ± 0.68 kg/d), DG7 (15.30 ± 0.68 kg/d), and DG3 (16.15 ± 0.68 kg/d). Immediately after feeding on SUP d, ruminal pH of DGA was less than all other treatments, but by the end of the day was greater than all other treatments (treatment × time; $P < 0.001$). At the time of feeding on NSUP d, ruminal pH of DGA steers was greater than all other treatments but returned to levels similar (treatment × time; $P < 0.001$) to DG3 and CON by 5 h after feeding. On NSUP d, ruminal pH of steers fed DG7 was less ($P < 0.01$) than all other treatments until 9 h after feeding. On SUP d, steers fed DGA had decreased acetate to propionate ratio (A:P) from 4 to 8 h after feeding compared with other treatments, whereas DG7 and DG3 had an A:P less (treatment × time; $P < 0.001$) than CON from 2 to 4 h after feeding. Total-tract DM digestibility did not differ ($P = 0.18$) among treatments (56.9 ± 1.7%). The feeding strategy DGA altered DMI, ruminal pH, and concentrations of VFA without affecting DM digestibility.

Key Words: cattle, digestibility, distillers grains, ruminal fermentation

22 Effects of selection for blood serum insulin-like growth factor I (IGF-I) concentration on reproductive performances of female Angus beef cattle. X. Zhang* and M. Davis, *The Ohio State University, Columbus.*

The objectives of our study were to determine the differences in female reproductive traits between lines of Angus beef cattle selected for high vs. low serum insulin-like growth factor I (IGF-I) concentration; and estimate the (co)variances for IGF-I concentration and reproductive traits. Data were collected from a divergent selection experiment for serum IGF-I concentration in Ohio. Numbers of observations for IGF-I concentration at d 28 (IGF28), 42 (IGF42) and 56 (IGF56) of the 140-d postweaning test, mean of the 3 concentrations (MEANIGF), age of heifers at first calving (AFC), conception rate (CR), calving rate (CAR) and twinning rate (TW), were 1,978, 1,975, 1,973, 1,977, 403, 3,913, 3,686 and 2,656, respectively. Total number of calves for the 1989 through 2005 calf crops was 2,662. Calves in the high line had higher means for IGF28, IGF42, IGF56, MEANIGF and CAR in the first 21-d interval of the calving season (line differences = 61.83 ng/mL, 53.14 ng/mL, 56.7 ng/mL, 60.55 ng/mL and 8.07%, respectively; $P < 0.001$), but lower AFC and TW (line differences = −4.02d and −0.4%, respectively; $P < 0.1$) than calves in low line. High line heifers also had higher CR (line difference = 6.97%; $P < 0.002$) than low line heifers. (Co)variance components were estimated for direct additive genetic effects using an animal model and multiple-trait, derivative-free, restricted maximum likelihood (MTDFRML) computer programs. Estimates of direct heritability for IGF28, IGF42, IGF56, MEANIGF, CR, CAR and AFC were 0.33 ± 0.06, 0.43 ± 0.07, 0.35 ± 0.06, 0.50 ± 0.07, 0.11 ± 0.05, 0.10 ± 0.03 and 0.35 ± 0.20, respectively. Estimates of direct heritability for CR and CAR in heifers were 0.20 ± 0.11 and 0.11 ± 0.10, respectively. The genetic correlations of MEANIGF with AFC, CR and CAR for heifers were −0.40 ± 0.11, 0.29 ± 0.00, 0.31 ± 0.00, respectively. These results suggest that selection for high IGF-I concentration could lead to increased conception rate and calving rate, and decreased age at first calving in heifers.

Key Words: insulin-like growth factor I, selection, reproduction, heritability

23 Conception rates (CR) in grazing dairy cows treated with 14-d CIDR or 14-d CIDR+$PGF_{2\alpha}$ for presynchronization before a timed AI (TAI). R. C. Escalante*, S. E. Poock, D. J. Mathew, W. R. Martin, E. M. Newsom, S. A. Hamilton, K. G. Pohler, and M. C. Lucy, *University of Missouri, Columbia.*

Progesterone-containing devices (CIDR; Pfizer, New York, NY) inserted for 14 d are used to presynchronize the estrous cycle for TAI in beef heifers (14-d CIDR-PG program; http://beefrepro.unl.edu). Some cattle will retain a corpus luteum for the entire 14 d period and will not develop a persistent follicle during CIDR treatment. These cattle are not presynchronized effectively. The objective was to test the effect of a luteolytic dose of $PGF_2\alpha$ (5 mL Lutalyse; Pfizer) at CIDR removal for improving synchrony of estrus after presynchronization and increasing CR to TAI. Postpartum cows (Holstein, Jersey or crossbred; n = 1022; ≥ 30 d postpartum) from 2 grazing dairy farms were assigned to one of 2 programs: 14dCIDR (Control; CIDR in, 14 d, CIDR out; n = 523) or 14dCIDR+$PGF_2\alpha$ [Treatment (Trt); CIDR in, 14 d, CIDR out+$PGF_2\alpha$; n = 499]. Cows were body condition scored (BCS; 1 to 5; thin to fat) and tail painted at CIDR removal. Paint score (PS) was recorded within 5 d of CIDR removal [PS = 0 (all paint removed, estrus) or PS = 3 (paint partially removed) or PS = 5 (no paint removed; no estrus)]. At 19 d after CIDR removal, all cows were treated with $PGF_2\alpha$ and then 56 h later treated with GnRH (2 mL Factrel, Pfizer) and then 16 h later TAI. Treating cows with $PGF_2\alpha$ at CIDR removal increased ($P < 0.001$) the percentage with PS = 0 within 5 d (68.4 vs 57.6%; trt vs control). Trt and control cows were similar for TAI CR (43.3 and 40.7%; respectively). There was an effect of PS after CIDR removal ($P < 0.001$) because cows with PS = 0 had greater CR than cows with PS = 3 or PS = 5 (48.4, 34.9, and 28.1%, respectively). The TAI CR increased ($P < 0.001$) with increasing BCS (30, 44, and 55% for 2, 3, and 4 BCS) and decreased ($P < 0.001$) with parity (50, 38, and 38% for 1, 2 and ≥ 3). There was no interaction of PS, BCS, parity, or farm with trt. Cows with PS = 0 after presynchroni-

zation had greater CR to TAI, however; the improvement in percentage of cows with PS = 0 after 14dCIDR+$PGF_2\alpha$ was not large enough to affect CR to TAI.

Key Words: cow, synchronization, dairy

24 Impact of starter pig feeding on subsequent growth performance and carcass characteristics. D. Skinner*, D. Wey, M. Rudar, C. Levesque, K. De Ridder, C. H. Zhu, and C. F. M. de Lange, *Centre for Nutrition Modelling, Department of Animal and Poultry Science, University of Guelph, Guelph, ON, Canada.*

Reductions in starter pig growth performance may induce compensatory growth in growing-finishing pigs. An experiment was conducted to examine the effect of diet complexity and in-feed antibiotics during the starter phase on subsequent growth performance and carcass quality. Four dietary treatments were used in a 2 × 2 factorial design based on diet complexity – low [L] vs. high [H] (varying levels of blood plasma, whey and synthetic AA) – and in-feed antibiotics (400 [A+] vs 0 [A-] mg/kg Aureomycine100). Pigs were weaned at 3 wk old (7.11 ± 0.99 kg BW). Starter diets were fed in a 3-phase feeding program (1, 2 and 3 wk duration for phase 1, 2 and 3, respectively). Thereafter, in the grower-finisher phase (GF) all pigs were fed common diets. The data presented is from 3 blocks with 3 pens per treatment per block. Blocks 1 and 2 had 8 pigs/pen while block 3 had 10 pigs/pen, with the added pigs being removed for tissue sampling. Pigs were slaughtered at 110–115 kg BW. ADG was lower ($P < 0.05$) for L than for H in phase 1 (92 vs. 132 g/d), phase 2 (420 vs. 453 g/d) and phase 1 to 3 (510 vs. 533 g/d). An ADG response to antibiotics was only observed ($P < 0.05$) in phase 3 (699 for A- vs. 740g/d for A+) and phase 1 to 3 (505 for A- vs. 538 g/d for A+). During phase 1 to 3, G:F was higher ($P < 0.05$) for A+ than A- (0.61 vs. 0.59), while there was an interactive effect ($P < 0.05$) of diet complexity and antibiotics (0.60, 0.60, 0.58 and 0.62 for HA-, HA+, LA- and LA+, respectively). During the GF phase, pigs on A- grew faster than pigs on A+ ($P < 0.05$; 1071 vs. 1029 g/d). There were no treatment effects ($P > 0.10$) on G:F for the overall experimental period. At slaughter, there were no treatment effects ($P > 0.10$) on loin depth, fat depth, estimated carcass lean yield or days from weaning to slaughter. These results show that feeding antibiotic-free and low complexity diets compromises growth performance during the starter phase, but induces compensatory growth thereafter. Feed costs for starter pigs can be reduced by feeding less complex diets without compromising growth performance up to market weight or carcass value

Key Words: pigs, growth performance, nursery, compensatory growth

25 High sulfur content in dried distillers grains with solubles (DDGS) protects against oxidized lipids in DDGS by increasing sulfur-containing antioxidants in nursery pigs. R. Song*[1], C. Chen[1], L. J. Johnston[2], B. J. Kerr[3], T. E. Weber[3], and G. C. Shurson[1], *[1]University of Minnesota, St. Paul, [2]West Central Research and Outreach Center, Morris, MN, [3]USDA-ARS-NLAE, Ames, IA.*

Some sources of DDGS contain relatively high amounts of oxidized lipids produced from PUFA peroxidation during the production process. These oxidized lipids may negatively affect growth performance and metabolic oxidation status of pigs. The objective of this study was to understand the effects of feeding corn-soybean meal diets (CON) or diets containing 30% DDGS with 3 levels of vitamin E (α-tocopheryl acetate): none supplemented, NRC level (11 IU/kg), and 10X NRC (110 IU/kg) on oxidative status of nursery pigs. The DDGS source used in this study contained the highest thiobarbituric acid reactive substances (TBARS) value, peroxide value, and total S content (5.2 ng/mg oil, 84.1 mEq/kg oil, and 0.95%, respectively) among 30 other DDGS sources sampled (mean values = 1.8 ng/mg oil, 11.5 mEq/kg oil, and 0.50%, respectively). Barrows (n = 54) were housed in pens and fed the experimental diets for 8 wk after weaning and transferred to individual metabolism cages for collection of feces, urine, blood, and liver samples. Total S content was higher in DDGS diets than CON (0.39 vs. 0.19%). Although pigs were fed highly oxidized DDGS in this study, serum TBARS were the same between DDGS and CON treatments. There was no interaction between dietary DDGS and α-tocopherol concentration of TBARS in serum. Serum α-tocopherol increased by feeding DDGS diets compared with CON (2.25 vs. 1.56 μg/mL, $P < 0.001$). Pigs fed DDGS diets had higher concentrations of S-containing AA, particularly methionine ($P < 0.001$) and taurine ($P = 0.002$) in serum of fed pigs, and a higher level of taurine in serum of fasted pigs ($P = 0.006$) compared with those fed CON. Liver glutathione concentration was higher in pigs fed DDGS diets than CON (56.3 vs. 41.8 nmol/g). The elevated level of S-containing antioxidants (methionine, taurine, glutathione) in vivo may protect pigs against oxidative stress when feeding highly oxidized DDGS. Therefore, increasing levels of α-tocopherol in diets containing DDGS with oxidized lipids may not be necessary to protect pigs from metabolic oxidation stress.

Key Words: DDGS, lipid peroxidation, sulfur-AA, vitamin E

26 Effect of sample size and method of sampling pig weights on the accuracy of estimating the mean weight of the population. C. B. Paulk*, G. L. Highland, M. D. Tokach, J. L. Nelssen, S. S. Dritz, R. D. Goodband, and J. M. DeRouchey, *Kansas State University, Manhattan.*

An accurate estimate of the mean weight of a pig population is critical for producers to maximize profit when marketing pigs. Using a computer program developed in R (R Foundation for Statistical Computing, Vienna, Austria), 10,000 sample means were generated to simulate different methods of sampling a pig population using 2 different data sets. Sampling methods evaluated were: 1) completely random samples of 10 to 200 pigs from the barn, 2) an increasing number of pigs per pen from 1 to 15 or the entire pen, and 3) increasing the number of pens sampled until all pens had been sampled. Data set A consisted of 1,260 individually weighed pigs with 23 to 28 pigs per pen in 48 pens. The mean, median and SD of the population were 114.8, 115.2, and 14.9 kg, respectively. Data set B consisted of 1,261 individually weighed pigs with 56 to 81 pigs per pen in 19 pens. The mean, median, and SD of the population were 96.9, 97.1, and 9.8 kg, respectively. Increasing the number of random pigs sampled or increasing the number of pens sampled decreased the 95% confidence interval about the mean (CI; Table 1); however, 130 and 60 pigs had to be sampled to achieve a 95% CI of less than 5 kg for the 2 data sets respectively. For a defined sample size (ex. Thirty pigs), CI was reduced as the number of pens sampled was increased for both data sets. In conclusion, increasing the number of pigs sampled and increasing the number of pens sampled for a fixed number of pigs improves accuracy of estimating the mean weight of pigs in a population.

Table 1. Effect of sampling on range between the upper and lower 95% CI

Completely random			Increasing the number of pens			
Pigs	A	B	Pigs	Pens	A	B
10	18.6	12.0	15	2	14.5	11.9
30	10.4	6.8	10	3	13.0	10.0
50	8.1	5.3	6	5	12.1	8.4
70	6.8	4.6	5	6	11.7	7.9
90	5.8	3.9	3	10	11.1	7.1
110	5.3	3.5	2	15	10.7	6.7
130	4.9	3.2	1	30	10.5	N/A

Key Words: finishing pig, mean estimation, sample size

27 Effect of corn processing on feedlot steers fed sugar beet pulp. C. A. Nichols*[1], M. K. Luebbe[2], K. H. Jenkins[2], G. E. Erickson[1], S. A. Furman[2], and T. J. Klopfenstein[1], *[1]University of Nebraska, Lincoln, [2]University of Nebraska-Lincoln Panhandle Research and Extension Center, Scottsbluff.*

A finishing trial was conducted to evaluate feeding 0, 10, or 20% beet pulp (DM basis) in either dry-rolled corn (DRC) or steam-flaked corn (SFC) finishing diets. The study utilized 432 yearling British × Continental steers (314 ± 25 kg) in a randomized complete block design with a 2 × 3 factorial treatment structure with 6 replications for each simple effect. All diets contained 20% wet distillers grains plus solubles, 15% corn silage, and 6.0% liquid supplement (DM basis). No significant corn processing × beet pulp interaction was detected ($P > 0.05$) for finishing performance and carcass data. Final BW, DMI, and ADG decreased linearly ($P < 0.01$) with increasing levels of beet pulp in both DRC and SFC diets, however, G:F was not different ($P = 0.49$) among levels of beet pulp in the finishing diet. The inclusion of 20% beet pulp in DRC based diets decreased ADG by 9.1% compared with diets without beet pulp. In SFC based diets the inclusion of 20% beet pulp decreased ADG 4.2%. The lack of difference in G:F is because the change in magnitude for DMI (9.8 and 4.6%, for DRC and SFC, respectively) was similar to the change noted for ADG when 20% beet pulp was included. Hot carcass weight, YG, and 12th rib fat thickness decreased linearly ($P < 0.01$) as level of beet pulp increased in the diet. Beet pulp inclusion did not affect marbling score or LM area ($P = 0.20$). Cattle fed DRC based diets had greater DMI ($P = 0.03$) compared with cattle fed diets containing SFC. Feeding SFC improved ($P < 0.01$) G:F compared with diets with DRC as the grain source. Average daily gain was not different ($P = 0.42$) between the 2 different corn processing methods. Corn processing method did not affect carcass characteristics ($P > 0.17$). In summary, there was no beet pulp by corn

processing interaction. The inclusion of beet pulp in the finishing diet decreased DMI and ADG which is consistent with previous research.

Key Words: beet pulp, corn processing, feedlot cattle

28 Relationship of placental and endometrial vascularity and muscle characteristics of fetal pigs. T. A. Wilmoth*[1], E. K. Harris[2], E. P. Berg[2], M. E. Wilson[1], and K. A. Vonnahme[2], *[1]West Virginia University, Morgantown, [2]North Dakota State University, Fargo.*

We have previously observed an increase in umbilical blood flow to fetuses in exercised compared with control sows [Harris 2010. JAS 88(E-Suppl. 3):27]. This could lead to increased nutrient delivery to the fetus influencing its development, particularly muscle development. The objective of this study was to determine the effects of exercise in second parity sows on placental and endometrial vascularity and muscle development. Sows were bred by AI and assigned to exercise (n = 3) or control (n = 3) groups. After acclimation to exercise, sows were exercised for 30 min 3 times per week beginning on d 44 of gestation. On d 94 of gestation sows were ovario-hysterectomized and fetuses from the tip, mid and base of each horn were removed. Fetal semitendinosus muscles were removed, weighed and stored for fiber typing. Uterine cross sections were fixed in formalin for determination of vascular density. Endometrial (EVD) and placental vascular densities (PVD) did not differ between the exercised and control groups (23.48 ± 2.14 and 34.63 ± 3.69, respectively). Semitendinosus weights (StW) were also similar for both groups (1.74 ± 0.09). Similarly, no differences were found for the number of primary (P) or secondary (S) fibers of the semitendinosus muscle when comparing the exercised and control groups (39.33 ± 4.27 and 142.00 ± 12.14, respectively). However, EVD and PVD were positively correlated (r = 0.52, $P < 0.05$). EVD was found to have relationships to S (r = 0.81, $P < 0.09$) and placental weight (r = −0.56, $P < 0.05$). PVD and P were positively correlated (r = 0.64, $P < 0.05$). Fetal weight (r = 0.80) and placental weights (r = 0.43) had a positive relationship with StW ($P < 0.05$). Also, P and S tended to be negatively correlated (r = −0.59, $P = 0.07$). Blood flow to the feto-placental unit influences the development of the fetus and the placenta. Importantly, these effects can alter the development of muscle during a time when that development is critical, and potentially alter the meat quality of the animal.

Key Words: exercise, muscle development, pregnancy

29 Effects of prepartum feeding strategy on reproductive performance and health in dairy cows: A meta-analysis approach. F. C. Cardoso*[1], S. J. LeBlanc[2], M. R. Murphy[1], and J. K. Drackley[1], *[1]University of Illinois, Urbana, [2]University of Guelph, Guelph, ON, Canada.*

To investigate the association between prepartum energy feeding regimen and reproductive performance and health, cow-level data from 7 different experiments completed in our group from 1993 to 2010 were analyzed. Days to conception (DTC) was the variable used to assess reproductive performance. A total of 408 cows (354 multiparous and 54 primiparous) were included. The net energy for lactation (NE_L) intake (NE_{LI}) was calculated from the cow's respective dietary NE_L density and average DMI. Treatments consisted of controlled energy (CE; median NE_{LI} = 13.7 Mcal/d) or high energy (HE; median NE_{LI} = 22.1 Mcal/d) diets fed during the far-off (FO) or close-up (CU) dry periods. The Cox proportional hazard model revealed significant differences in DTC between HE and CE fed during CU (median = 167 and 157 d; hazard ratio (HR) = 0.7, $P = 0.04$). Cows on HE diets during the last 4 wk prepartum lost more BCS in the first 6 wk postpartum than those fed CE (−0.43 and −0.30, respectively, $P = 0.04$). Feeding CE during FO had a positive association with energy intake in the first 6 wk postpartum compared with HE during FO ($P = 0.01$). Cows fed CE during FO had lower NEFA concentrations in wk 1, 2, and 3 of lactation ($P < 0.01$). High NEFA (>700 μEq/L) concentration in wk 1 was associated with a greater probability of diseases (n = 251; OR = 1.2, $P < 0.05$). High (>60 mg/dL) plasma glucose (HG) in wk 3 (HG, n = 154; low glucose [LG], n = 206) and wk 4 (HG, n = 71; LG, n = 254) after calving was associated with shorter DTC as compared with LG (wk 3: median = 151 and 171 d; HR = 1.3; wk 4, median = 148 and 167 d; HR = 1.4; $P = 0.04$). In conclusion, cows fed CE during CU had a shorter interval between parturition and pregnancy. This may be explained by increased energy intake in the first 4 wk postpartum and lower incidence of disease. In addition, less BCS loss in the first 6 wk and slightly higher glucose concentrations early postpartum likely contributed to improved reproductive performance.

Key Words: energy intake, transition period, reproductive performance

30 Evaluation of probiotics with different energy and nutrient density on growth performance, nutrient digestibility, blood characteristic, fecal microbial shedding and fecal noxious gas content in growing pigs. L. Yan*, S. C. Kim, and I. H. Kim, *Department of Animal Resource & Science, Dankook University, Cheonan, Choongnam, South Korea.*

The study was conducted to evaluate the probiotics supplementation (*Enterococcus faecium*, 1.0×10^{10} cfu/g) with different energy and nutrient densities in growing pigs. A total of 144 pigs with initial BW of 29.48 ± 0.58 kg were used in a 6-wk experiment. Pigs were randomly allotted to 1 of 4 treatments in a 2 × 2 factorial arrangement of treatments with 2 levels of energy and nutrient density (low and high energy, CP, and Lys) and 0.1% probiotics according to their sex and BW (9 pens with 2 gilts and 2 barrows per pen). In the current study, pig fed the higher energy and nutrient density diets led to a higher ($P < 0.05$) ADG and G:F ratio than those fed low energy and nutrient density diet. The inclusion of probiotics increased ($P < 0.05$) ADG, ADFI, G:F, and the apparent total tract digestibility of DM, N, energy. Moreover, dietary high energy and nutrient density diet led to a higher ($P < 0.05$) cholesterol, triglyceride concentration, fecal H_2S and NH_3 content, whereas the probiotics supplementation led to a reduced ($P < 0.05$) cholesterol, triglyceride concentration, and fecal H_2S and NH_3 content. An increased fecal lactobacillus concentration was observed with probiotics supplementation. Furthermore, an interactive effect between energy and nutrient density diet and probiotics was observed on the ADG and G:F ratio, fecal lactobacillus, apparent total tract digestibility, and fecal NH_3 and H_2S content. In conclusion, both dietary probiotics supplementation or high energy and nutrient diet could improve growth performance and nutrient digestibility in growing pigs. The beneficial effect of probiotics supplementation in pigs could be enhanced with the high energy and nutrient density diets.

Key Words: nutrient density, probiotics, growing pigs

31 Sodium salicylate treatment immediately postpartum increases energy-corrected milk yield primarily through an increase in milk fat secretion in dairy cattle. J. K. Farney*, L. K. Mamedova, J. E. Minton, J. F. Coetzee, L. C. Hollis, and B. J. Bradford, *Kansas State University, Manhattan.*

Research has identified a possible link between inflammation and metabolic disorders. In theory, improvement in health may be accomplished by moderating inflammation. The purpose of this experiment was to determine if a nonsteroidal antiinflammatory drug, sodium salicylate (SS), benefits transition cows. At calving, 78 cows [n = 39 primiparous (1P); n = 28 2nd lactation (2P); n = 11 ≥ 3 lactations (3P)] were alternately assigned to either control (CON) or SS treatment for 7 d and remained on study until 21 d postpartum. Treatment was administered via individual water bowls at a concentration of 2.5 g/L, delivering a mean of 183 ± 8.5 g SS/d during the 7 d of treatment. Milk yields were collected daily and milk samples were collected twice weekly for component analysis. Data were analyzed using mixed models with repeated measures over time, and tested effects of parity, treatment, time, and all 2- and 3-way interactions. There were no overall treatment effects on feed or water intake. Milk yield for 3P cows tended to increase with SS at the end of the trial (51.4 vs. 41.4 ± 3.4 kg/d on d 19–20, $P < 0.10$). Milk protein content was increased with SS in 1P and 2P cows in wk 1 ($P < 0.05$), and milk urea nitrogen was decreased ($P < 0.01$) by SS. Milk fat content was increased with SS in wk 2 and 3 postpartum (5.02 vs. 4.54 ± 0.15%, $P < 0.05$). There was a 10% increase in energy-corrected milk yield for SS in wk 3 (50.2 vs. 45.5 ± 1.7 kg/d, $P < 0.05$). Metritis incidence was increased with SS in 3P cows ($P < 0.01$), but no other effects on disease incidence were detected. In contrast to our hypothesis that SS-treatment would decrease transition disorder incidences, SS treatment increased milk fat content and milk energy output in early lactation with no effect on total disorder incidence. Responses to SS suggest that inflammation (in control cows) has effects on productivity, possibly via alterations in nutrient flux.

Key Words: nonsteroidal antiinflammatory drug, transition cow, inflammation

32 Effect of chronic dietary exposure of deoxynivalenol on serotonin concentration in the hypothalamus and behavior of pigs. Y. B. Shen*, A. C. Chaytor, and S. W. Kim, *North Carolina State University, Raleigh.*

Studies have shown that administration of deoxynivalenol (DON) increases the catabolism of hypothalamic serotonin. This study was to investigate the effect of chronic dietary exposure of DON from naturally contaminated corn on hypothalamic serotonin concentration, growth, and behavior of pigs. Eight individually housed pigs were paired based on sex and body weight and randomly allotted to 2 dietary treatments with 0.0 mg or 3.0 mg DON/kg. Both diets had 0.4% added L-Trp to be used as substrates for serotonin synthesis. Pigs were fed the assigned diets for 21 d. Pigs were pair-fed to maintain the same feed intake between treatments. Body weight was measured on d 7, 14, and 21. On d 6, 13, and 20, percentage of time that pigs spent on various behaviors, including lying, sitting, eating, standing, and drinking was recorded. On d 21, all pigs were euthanized to obtain the hypothalamus. During the first 7 d, pigs fed the diet contaminated with DON had greater ADG ($P = 0.075$) and G:F ($P = 0.011$) compared with pigs fed the uncontaminated diet. During the entire study, however, dietary DON did not affect ADG, ADFI, and G:F of pigs. Pigs fed the diet contaminated with DON tended to have lower hypothalamic serotonin (155.5 vs. 110.9 ng/mg; $P = 0.092$) compared with pigs fed the uncontaminated diet. Pigs fed the diet contaminated with DON tended to spend less time for drinking on d 6 (0.71 vs. 1.49%; $P = 0.071$), 13 (0.48 vs. 1.37%; $P = 0.072$), and 20 (0.48 vs. 1.90%; $P = 0.032$) in contrast to pigs fed the uncontaminated diet. On d 20, pigs fed the diet contaminated with DON tended to spend more time for sitting (1.49 vs. 0.54%; $P = 0.099$) and less time for standing (8.45 vs. 13.87%; $P = 0.091$). Overall, feeding pigs 3.0 mg DON/kg reduced the concentration of hypothalamic serotonin, which may be responsible for the changes in pig with reduced drinking, increased sitting, and reduced standing behaviors.

Key Words: deoxynivalenol, tryptophan, pigs, serotonin

33 Effects of aflatoxin and deoxynivalenol on oxidative stress in pigs. A. C. Chaytor* and S. W. Kim, *North Carolina State University, Raleigh.*

Three Exp. were conducted to determine the role of aflatoxin (AF) and deoxynivalenol (DON) on lipid peroxidation and oxidative DNA damage in pigs. In Exp. 1, 60 gilts (13.9 ± 0.2 kg BW) were randomly allotted to 4 treatments (5 replicates, 3 pigs per pen) with varying mycotoxin levels for 33 d. Treatments were A (undetectable AF or DON); B (64 μg AF/kg + 320 μDON/kg); C (124 μg AF/kg + 548 μg DON/kg); and D (182 μg AF/kg + 768 μg DON/kg). In Exp. 2 and 3, gilts were allotted to 2 treatments with 3 pigs per pen for 42 d (Exp. 1, n = 30, 8.8 ± 0.4 kg BW, 15 replicates; Exp. 3, n = 28, 10.4 ± 0.3 kg BW, 14 replicates). In Exp. 2, diets were CON (undetectable AF and DON) or MTX (150 μg AF/kg + 1,100 μg DON/kg) and in Exp. 3, diets were CON (300 μg DON/kg) or DON (4,800 μg DON/kg). For all Exp., BW and feed intake were measured weekly, and pigs had free access to feed and water. Blood samples were collected at the end of each Exp. to analyze malondialdehyde (MDA) as a measure of lipid peroxidation, and 8-hydroxy-deoxyguanosine (8-OHdG) as a measure of oxidative DNA damage. In Exp. 1, ADG and ADFI decreased linearly (0.52 to 0.41 kg, $P = 0.010$; and 1.04 to 0.88 kg, $P = 0.009$, respectively) as dietary concentrations of AF and DON increased. Plasma MDA linearly increased (4.26 to 6.86 μM, $P = 0.031$) as AF and DON increased. In Exp. 2, pigs fed MTX had reduced ADG (0.83 kg, $P = 0.032$) and tended to have reduced ADFI (1.66 kg, $P = 0.053$) compared with pigs fed CON (0.93 and 1.80 kg). Plasma MDA and 8-OHdG were not altered ($P > 0.10$) by mycotoxin contamination. In Exp. 3, pigs fed DON had decreased ADG and ADFI (0.36 kg, $P = 0.001$; 0.72 kg, $P < 0.001$), and increased plasma 8-OHdG (0.85 ng/mL, $P = 0.031$) in contrast to CON (0.48 kg, 1.03 kg, and 0.56 ng/mL, respectively). This study indicates that both AF and DON can decrease growth performance. However, it appears that AF may be responsible for lipid peroxidation at a contamination level greater than 182 μg/kg, whereas DON may cause oxidative DNA damage at a contamination level greater than 4,800 μg/kg.

Key Words: aflatoxin, deoxynivalenol, oxidative stress, pigs

34 Development of an in vitro heat stress model for pig oocyte maturation. E. C. Wright*, C. X. Yang, R. Scanlon, C. K. Tuggle, and J. W. Ross, *Iowa State University, Ames.*

Heat stress (HS) before and during oocyte maturation has been shown to decrease conception rates and litter size demonstrating the susceptibility of the maturing oocyte to HS and its potential to negatively affect subsequent embryonic development. The objective of the present study was to develop an in vitro maturation system to model the negative implications of HS during in vitro maturation that demonstrated impaired embryonic development rates following the activation of the embryonic genome at the 4-cell stage. Three heat stress treatments were administered during in vitro oocyte maturation: control at 39°C for 42 h, heat stress (41°C) for 42 h (HS1), heat stress (41°C) for the last 21 h of maturation (HS2), and heat stress (41°C) for the first 21 h

of maturation (HS3). Control oocytes demonstrated the highest maturation rate (71.2 ± 3.7%), which was similar to HS2 (70.2 ± 0.7%) but greater than HS1 (55.1 ± 6.3%) and HS3 (54.0 ± 6.2%). HS1 oocytes had the lowest blastocyst development capacity (1.6 ± 1.1%), compared with the control (29.4 ± 4.5%), HS2 (13.3 ± 1.0%) and HS3 (21.6 ± 3.8%). Expression of MIR21, PDCD4 and HSP90A RNA was determined in GV, MII, and 4-cell stage embryos. MIR21 RNA was 18-fold greater in HS1 4-cell stage embryos, and its mRNA target PDCD4 was decreased 2 fold in 4 cell embryos compared with control. HSP90A expression was 8 fold greater in the 4-cell embryos of group HS1 compared with control. These RNA differences at the 4-cell stage demonstrate that HS during oocyte maturation alters gene expression in embryos that are similar morphologically but have reduced developmental capacity. The timing and duration of heat stress was reflected in reduced maturation rates, decreased developmental competency of embryos and altered gene expression of heat stress and developmental competency markers. MIR21 may provide a useful marker for developmental competence following heat stress during oocyte maturation. This work was funded in part by the Iowa Pork Producers Association.

Key Words: heat stress, oocyte, development, embryo

35 Reducing particle size enhances chemical treatment in cattle finishing diets. A. L. Shreck*[1], B. L. Nuttelman[1], W. A. Griffin[1], G. E. Erickson[1], T. J. Klopfenstein[1], and M. J. Cecava[2], *[1]University of Nebraska, Lincoln, [2]ADM Research, Decatur, IL.*

Previous research has demonstrated that a portion of the corn in the diet can be substituted for lime treated corn stover. Looking to enhance this strategy, we conducted a finishing experiment utilizing 30 pens (12 steers/pen) of calf-fed steers (initial BW 374 ± 4.5 kg) to evaluate the effects of particle size and chemical treatment. A randomized complete block (n = 2) design with a 2 × 2 + 1 factorial arrangement of treatments (6 replications per treatment) was used. Corn stover was ground to pass through a 2.54 or 7.62 cm screen and fed at 20% (DM basis) in its native form (untreated; 93.4% DM) or stored anaerobically at 50% DM with 5% CaO (treated). All diets contained 40% modified distillers grains plus solubles (MDGS, 59.3% DM), and equal ratio of high moisture or dry rolled corn, and 4% supplement. Diets were formulated to supply similar amounts of dietary Ca (DM basis). A control was included that contained 5% (DM basis) untreated stover (7.62 cm grindsize) and 51% corn (DM basis). Therefore, 15% additional corn was replaced in untreated and treated dietary treatments. Treated stover (56.4%) had lower NDF content (DM basis) than untreated (78.8%). No interactions between particle size and chemical treatment were noted in this trial ($P \geq 0.40$). Treated stover diets improved ($P \leq 0.02$) final BW (2.2%), HCW (4.5%), ADG (12.6%) and G:F (17.4%) compared with untreated. Untreated stover had greater (4.7%) DMI than treated stover ($P < 0.01$). Reducing particle size improved ($P \leq 0.01$) ADG (3.2%) and G:F (3.5%) but did not influence DMI ($P = 0.87$). Compared with control, diets with 20% treated corn stover had similar G:F (0.155 vs. 0.153), ADG (1.67 vs. 1.66 kg), DMI (10.9 vs. 10.7 kg), and percent Choice (86.1 vs. 79.5%). Up to 15% additional corn can be replaced with treated corn stover, when diets contain wet distillers grains, and may be further enhanced by reducing particle size before chemical treatment.

Key Words: chemical treatment, finishing diets, particle size

36 High levels of dried distillers grains with solubles (DDGS) in sow and nursery diets do not contribute to Mulberry Heart Disease (MHD). A. R. Hanson*[1], L. J. Johnston[2], S. K. Baidoo[3], J. L. Torrison[4], and G. C. Shurson[1], *[1]University of Minnesota, St. Paul, [2]West Central Research and Outreach Center, Morris, MN, [3]Southern Research and Outreach Center, Waseca, MN, [4]Veterinary Diagnostic Laboratory, St. Paul, MN.*

To evaluate whether including high dietary levels of DDGS compromises vitamin E (VE) and Se status and (or) the occurrence of MHD in swine, pregnant sows (n = 12, parity 2) were fed corn-soybean meal diets (C, 0% DDGS) or diets with DDGS (D, 40 and 20% in gestation and lactation) for 3 parities. In the 3rd parity, pigs were blocked by weaning BW within litter, penned, and allotted to 1 of 3 nursery diets (ND): 1) 0% DDGS, 2) 30% DDGS, and 3) 30% DDGS with 5× NRC (1998) level of VE, in a 3-phase program using a 2 × 3 factorial arrangement (n = 9 pens/treatment) of sow diet (S-D) and ND. Serum and milk were collected from sows and serum from pigs (n = 2 to 3/litter) on d 0 (farrowing), d 7, and d 19 (weaning). Pigs (1 pig/pen, n = 54) were bled at d 47, and d 68 of age, and harvested at d 68 to obtain livers and hearts for histopathological evaluation for MHD. Milk, serum, and liver samples were analyzed for α-tocopherol (α-T) and Se concentrations. Pig performance (ADG, ADFI) and typical farrowing data (e.g., litter size and BW at birth and weaning) were recorded. Data were analyzed using SAS (Mixed procedure), with repeated measures when appropriate. Pre-weaning data were analyzed to test the effect of S-D. Nursery data were analyzed as a split plot (litter = whole plot, pen = sub-plot) testing effects of S-D, ND and S-D x ND interactions. No characteristic lesions of MHD were detected. Overall pig and sow performance was not affected by diet ($P > 0.05$). Liver α-T concentration was greater in pigs fed ND 3 than those fed ND 1 or 2 ($P < 0.01$). Pigs from sows fed D had lower ($P = 0.07$) serum α-T (3.69 vs. 4.42 ± 0.31 μg/mL) and Se ($P < 0.01$) during lactation than those from sows fed C. Pigs from sows fed D had lower ($P = 0.08$) serum α-T concentration in the nursery than those from sows fed C (2.66 vs. 3.11 ± 0.22 μg/mL). Milk α-T was not affected by S-D ($P > 0.05$), but sows fed D had lower ($P < 0.05$) milk and serum Se concentrations than those fed C. Feeding diets with DDGS to sows may affect the VE status of pigs, but in this study, feeding 30% DDGS nursery diets did not cause MHD.

Key Words: vitamin E, mulberry heart, DDGS, swine

37 Determining the influence of dietary roughage concentration and source on rumen parameters related to sulfur toxicity. S. J. Morine*, M. E. Drewnoski, and S. L. Hansen, *Iowa State University, Ames.*

Feedlot cattle are often fed co-products from ethanol production that are rich in protein and energy but high in sulfur (S). Excess S can decrease intake, reduce gain and can result in S toxicity. Sulfate, when fed to ruminants, is reduced to sulfide by ruminal bacteria. Rumen sulfide can be converted to hydrogen sulfide (H_2S) in a pH dependent process. Elevated ruminal H_2S has been correlated to S toxicity. The objective of this study was to determine the impact of feeding 3 dietary concentrations of NDF from low quality chopped cornstalks or average quality chopped grass hay on rumen pH, H_2S concentration, and DMI of steers fed a high S diet. Six ruminally-fistulated steers (672 ± 32 kg) were used in a 6 × 6 Latin square design with 14 d periods and were fed diets containing 0.5% S, from a combination of distillers grains and condensed corn distillers solubles. The experimental design was a 2 × 3 factorial with 2 roughage sources: cornstalks or grass hay, at 1 of 3 levels of added roughage NDF (rNDF): 4, 7, or 10% rNDF. Cornstalk diets had a lower total NDF ($P = 0.02$) than diets with hay. However, effective NDF did not differ between source ($P = 0.3$). Effective NDF was linearly increased ($P < 0.01$) with increased inclusion of rNDF. There was no effect of level or source of rNDF on DMI ($P \geq 0.3$; 1.54 ± 0.22% BW). Ruminal pH did not differ by source ($P = 0.9$) but was increased ($P = 0.03$) as rNDF was increased from 4% (5.66) to 7% (5.96). However, ruminal pH did not differ ($P = 0.98$) between 7% and 10% (5.97) rNDF (SEM ± 0.10). Concentration of H_2S measured 6 h post-feeding on d 14 of each period did not differ by source ($P = 0.19$) and was greater ($P < 0.01$) in 4% (4013 ppm) than 7% (2345 ppm) or 10% (2689 ppm) rNDF, which did not differ ($P = 0.5$; SEM ± 337 ppm). Ruminal pH and H_2S data were strongly negatively correlated ($R = -0.65$; $P > 0.01$). The results of this study suggest that adding at least 7% NDF from cornstalks or hay to feedlot diets will increase ruminal pH and decrease H_2S concentrations, thus reducing potential of S toxicity.

Key Words: cattle, effective NDF, sulfur

38 Effects of feeding PetroAlgae's Lemna Meal to dairy heifers as a top-dress or as a total mixed ration. N. McDonald*[1], D. Wells[2], M. Rohlfsen[2], and N. B. Litherland[1], *[1]University of Minnesota, St Paul, [2]PetroAlgae LLC, Melbourne, FL.*

PetroAlgae's Lemna Meal (LM), a byproduct from the manufacture of bio-fuel from duckweed, has a favorable nutrient profile for ruminants. The objective of the this study was to determine if feeding Lemna meal pellets (25.7% of diet DM) either as a TMR or top-dress alters dry matter intake (DMI), growth or feeding behavior compared with a control TMR with alfalfa hay. We hypothesized that DMI of LM would be higher in a TMR compared with top-dress. Thirty-six Holstein and Swedish Red-Montbeliard cross-bred heifers were divided into 9 pens with 4 heifers per pen for the 30 d study. Pens were balanced by age (166.3 ± 7.4 d) and body weight (BW) (BW = 205.0 ± 1.6 Kg). Treatments were; TMR with Lemna pellets (LTMR); Top-dressed Lemna pellets (TTMR); (14.7% CP; 43.3%NDF; 1.1 Mcal/Kg ME) Alfalfa hay TMR (ATMR) (15.2% CP; 43.4%NDF; 1.0 Mcal/Kg ME). LTMR and TTMR were identical except for method of feeding Lemna pellets. Calves were adapted to the diets for 5 d before data collection. Data were analyzed using Proc Mixed in SAS as a completely randomized design using repeated measures when appropriate. LSmeans and Pdiff were used for mean separation. Total gain 22.9, 21.6, 19.7 ± 1.6 Kg/d and average daily gain (ADG) (0.79, 0.74, 0.68 ± 0.05 kg/d) were similar among treatments for LTMR, TTMR, ATMR. There was no difference among treatments for pen DMI 6.9, 6.7, 6.6 ± 1.8 Kg/d for LTMR, TTMR, ATMR. Similarities between DMI and ADG of heifers fed Lemna in a TMR or Top-dress compared with alfalfa supports our hypothesis that Lemna is a viable alternative to alfalfa meal for growing dairy heifers. Feeding and ruminating behavior was observed once weekly for 4 h after feed delivery. Feeding time was higher ($P < 0.05$) for ATMR compared with LTMR or TTMR and averaged 110.3, 90.3, 79.2 ± 7.5 min/4 h respectively. Ruminating time was similar and averaged 56.9, 48.6, 50.6 ± 5.0 min/4 h for LTMR, TTMR, ATMR. Greater feeding time is likely due to the physical form of ATMR. LM pellets are an attractive alternative to alfalfa pellets for dairy heifers during the growing phase.

Key Words: Lemna Meal, dairy heifer, top-dress, TMR

39 Supplementing glycerol in dairy nursery calf drinking water increases water intake but does not increase energy intake or calf growth. K. Froehlich*, D. N. L. Da Silva, and N. B. Litherland, *University of Minnesota, St. Paul.*

Providing water to nursery calves in hutches during sub-zero temperature is challenging. Water is required for all of life's processes. Glycerol, a byproduct of biodiesel production, lowers the freezing point of water acting as edible antifreeze. Our objectives were to determine if feeding glycerol in drinking water of nursery calves during winter will; 1) prevent water from freezing before consumption; 2) increase water intake; and 3) increase energy intake during cold stress. Thirty Holstein and cross-bred calves at the University of Minnesota, St. Paul from January to March of 2011 were assigned to treatments; no free water (NW), water (10% of birth body weight) (W), water (10% of birth body weight plus 180 g/d glycerol to yield a 4% glycerol solution) (WG). Treatments were fed through d 49. NW calves were fed free water on d 35–42 at PM and then at both AM and PM feedings on d 43–49. Calves were housed in individual hutches bedded with straw and fed a 20:20 all milk protein milk replacer (MR) at 1.5% of birth body weight at 12.5% solids and had ad libitum access to 18% CP starter grain. Glycerol contained < 0.01 ppm methanol. Water intake through 49 d increased ($P < 0.05$) for WG vs. NW and W averaging 0.0, 2.1, and 4.1 ± 0.3 kg/d for NW, W, and WG respectively. By d 7 all WG calves consumed their water before their drinking water froze. Starter intake tended ($P = 0.08$) to be lower for WG and averaged 1.1, 0.95, 0.76 ± 0.1 kg/d for NW, W, and WG. Offering warm water with glycerol directly after feeding MR may decrease starter intake due to fill effects of water. Average daily gain through 49 d was not different among treatments averaging 0.57, 0.53 and 0.54 ± 0.04 kg/d for NW, W, and WG. Body weight gain and withers height gain over 49 d was similar among treatments averaging 28.0, 25.8, 26.0 ± 2.2 Kg and 8.2, 8.4, 8.4 ± 0.8 cm for NW, W, and WG respectively. Total energy intake tended ($P = 0.08$) to be lower for WG. Addition of glycerol to drinking water doubled water intake compared with water alone but increased water intake did not improve performance.

Key Words: nursery calf, glycerol, water intake, winter feeding

40 The 2011 South Dakota equitarian survey and reservation equine comparative analysis. A. T. Gebhart*, K. Koch, and R. C. Bott, *South Dakota State University, Brookings.*

Economic stress and geographic isolation are barriers to proper veterinary care for horses on US Native American reservations. The 2011 South Dakota (SD) equitarian survey was distributed to 135 equine veterinarians in SD (response rate 39%) to detect perceptions of effectiveness and best methodologies for improving reservation equine welfare. Correlation coefficients and a Chi-squared test of associations were used to compare trends in answers. There was a positive correlation ($P < 0.005$) between responses regarding perceived importance and effectiveness of increased veterinary access and the importance of free care and owner knowledge in changing the health and welfare of a SD reservation equine population. Thirty-nine percent of respondents claimed to have an interest in providing help for reservation equines; those with no veterinary experience on reservations tended to not have an interest ($P = 0.05$). Previous experience practicing on a reservation affected how crucial they believed horse owner knowledge or awareness is in changing the health and welfare of reservation equines ($P < 0.04$). The most commonly noted health threat and strength were poor nutrition (67.9%) and the absence of internal disease (15.52%), respectively. In a subsequent analysis, 299 horses on the Cheyenne River Sioux Reservation were observed for welfare indicators and divided into groups by use: saddle, production, bucking stock, and performance. Data were analyzed using ANOVA and means were separated using a Tukey test. Horses from 5 of the 12 observed properties were vaccinated at least once yearly. Average BCS was 5 out of 9 and did not differ between the 4 groups ($P = 0.17$). Coat ($P < 0.001$) and hoof ($P < 0.007$) condition varied between groups with optimal scores for each occurring in the performance and saddle horse groups, respectively. Although nutrition was the primary concern of veterinarians, most reservation equines presented fair BCS. Variable hoof, coat, and vaccination practices among the groups of reservation equines present an opportunity for health care education and welfare improvement.

Key Words: equitarian, reservation, welfare

41 The effects of glucuronic acid and N-acetyl-D-glucosamine supplementation on the in vitro production of porcine oocytes. A. L. Buck*, A. R. Clark, and T. M. Donley, *The University of Findlay, Findlay, OH.*

The objective of this study was to assess the in vitro fertilization (IVF) and embryo development of pig oocytes supplemented with components of the perivitelline space. Glucuronic acid or N-acetyl-D-glucosamine (GlcNAc) were supplemented (2.5, 5.0 m*M*) to the media during the last 24 h of oocyte maturation. At the end of maturation, oocytes (n = 500) were evaluated for zona pellucida and perivitelline space thickness, intracellular levels of glutathione, and fertilization kinetics at 12 h after IVF. A portion of the embryos (n = 250) were cultured and evaluated for cleavage and blastocyst formation at 48 h and 144 h after IVF, respectively. Oocytes not supplemented had thicker ($P < 0.05$) zona pellucida than all other treatments. The zona pellucida of the 2.5 and 5.0 mM glucuronic acid supplementation were thicker ($P < 0.05$) than the 2.5 and 5.0 mM GlcNAc supplementation. Oocytes not supplemented also, had a thinner ($P < 0.05$) perivitelline space compared with the other treatments. There were no differences between the treatments when evaluating intracellular glutathione concentrations, sperm penetration or male pronuclear formation. However, 2.5 and 5.0 m*M* supplementation of GLcNAc increased ($P < 0.05$) polyspermic penetration compared with the other groups. No supplementation and glucuronic acid supplemented oocytes had a higher ($P < 0.05$) percentage of embryos cleaved by 48 h and blastocysts by 144 h after IVF, compared with the GlcNAc supplemented oocytes. Results indicate that glucuronic acid supplementation during oocyte maturation increases perivitelline space thickness and embryonic development, and reduces polyspermic penetration compared with GlcNAc supplementation. These findings suggest that glucuronic acid is involved in the successful block of polyspermic penetration.

Key Words: in vitro fertilization, polyspermy, perivitelline space, swine

42 Effects of maternal nutrient restriction and melatonin supplementation on fetal cardiomyocyte maturation and enlargement. E. A. Nere*[1], C. O. Lemley[1], A. M. Meyer[2], and K. A. Vonnahme[1], *[1]North Dakota State University, Fargo, [2]University of Wyoming, Laramie.*

Using a maternal nutrient restriction model, we examined fetal cardiomyocyte maturation and enlargement during dietary melatonin supplementation in a 2 × 2 factorial design. At d 50 of gestation, 31 primiparous ewes were allocated to receive 100% (adequate; ADQ) or 60% (restricted; RES) of nutrient requirements and were supplemented with 5 mg of melatonin per d (MEL) or no melatonin (CON) until d 130. Ewes were exposed to a 12:12 light-dark cycle with lights on at 0700 h and off at 1900 h. Ewes were fed and/or supplemented with melatonin at 1400 h each day. At d 130 of gestation ewes were euthanized and fetal hearts were collected. Fetal heart weight, heart weight relative to fetal weight, left and right ventricle thickness, and percentage left and right ventricle cardiomyocyte binucleation were not different ($P > 0.5$) between treatment groups. Left ventricle mononucleated cardiomyocyte area (μm^2) was increased ($P < 0.05$) in fetuses from CON-RES vs. CON-ADQ and MEL-RES dams. Left ventricle mononucleated cardiomyocyte area relative to fetal heart weight ($\mu m^2/g$) was increased ($P < 0.05$) in CON-RES vs. CON-ADQ dams. Left ventricle binucleated cardiomyocyte area and area relative to fetal heart weight were increased ($P < 0.02$) in CON-RES and MEL-ADQ vs. CON-ADQ dams. In addition, left ventricle binucleated area and area relative to fetal heart weight were decreased ($P < 0.01$) in MEL-RES vs. CON-RES. Right ventricle mononucleated cardiomyocyte area and area relative to fetal heart weight were not different ($P > 0.3$) among treatment groups. Right ventricle binucleated cardiomyocyte area and area relative to fetal heart weight were increased ($P < 0.01$) in fetuses from CON-RES, MEL-ADQ, and MEL-RES vs. CON-ADQ dams. Maternal melatonin supplementation and nutrient restriction interacted to effect fetal cardiomyocyte enlargement, whereby melatonin supplementation during maternal nutrient restriction may reverse left ventricular cardiomyocyte enlargement. However, this effect was absent in the right ventricle, which may potentially alter offspring cardiovascular function and performance.

Key Words: fetal cardiomyocyte, gestational nutrition, melatonin

43 Dietary cation-anion difference: Variable levels alter ad libitum feed intake. C. Rashid*[1], S. Gasca[1], P. Walker[1], and R. Hall[2], *[1]Illinois State University, Normal, [2]Animal Feed and Nutrition, Franklin, IN.*

Ad libitum feeding for gestating sows in group housing could improve sow welfare by reducing aggression during eating. However, overconsumption of energy and increased BCS is a concern when using self-feeders for sows. Dietary cation-anion difference (DCAD) has

been observed to decrease feed intake in self-fed pigs. The objective of this study was to observe the effects of DCAD in self-fed diets of group housed replacement gilts on backfat (BF), BCS, BW, ADG, and DMI. A 69-d study utilized 48 six-month-old gilts, blocked by BW (4 blocks, mean BW = 120, 124, 128, and 132 kg) and stratified within each block by BW to 3 pens (4 gilts/pen) subject to shifting to equalize BF. Body condition scores ranged from 1 = thin to 5 = fat. Three shelled corn-soybean meal based diets were randomly assigned to pens within block containing either 50 (C), −225/−550 (T1), or −450 (T2) DCAD (mEq/kg). The T1 diet contained −225 mEq/kg DCAD for the first 15 d and −550 mEq/kg from d 16 to 69. The diets containing C and T2 were fed for 69 d. Gilts consuming T1 and T2 had lower ($P \leq 0.05$) BF, BCS change, total BW gain, ADG, and DMI than C fed gilts comparing 1.44 ± 1.13 and 0.81 ± 2.07 to 4.31 ± 2.13mm; −0.08 ± 0.09 and −0.11 ± 0.27 to 0.05 ± 0.14; 21.68 ± 1.72 and 22.05 ± 5.03 to 39.46 ± 4.39kg; 0.31 ± 0.02 and 0.32 ± 0.07 to 0.57 ± 0.06kg; and, 1.97 ± 0.42 and 1.97 ± 0.30 to 2.59 ± 0.42kg/d, respectively. No significant differences in BF, BCS, BW gain, ADG, or DMI were observed between T1 and T2 fed gilts. Mean BCS between treatments were not different ($P \leq 0.05$) at the start of the study (3.03 ± 0.04) and at the end of the study (2.98 ± 0.14). Similar ($P \leq 0.05$) G:F ratios were observed for C, T1 and T2 fed gilts. This study found that decreasing DCAD in the feed of ad libitum fed replacement gilts can limit BW gain and BF deposition by limiting feed intake without negatively affecting BCS.

Key Words: group housing, ad libitum feeding, dietary cation-anion difference

44 Effect of selection for residual feed intake on sow performance II: Milk composition. A. Rakhshandeh[1], B. M. Adamic*[1], J. M. Young[1], D. M. Thekkoot[1], T. E. Weber[2], J. C. M. Dekkers[1], M. A. McGuire[3], and N. K. Gabler[1], *[1]Iowa State University, Ames, [2]USDA-ARS, Ames, IA, [3]University of Idaho, Moscow.*

We have observed that during lactation, sows genetically selected for low residual feed intake (LRFI) had lower daily feed intake and body fat content, and more severe negative energy balance. The current study was conducted to evaluate the effect of selection for RFI on sow milk composition. A total of 20 second-parity sows (body weight 179 ± 5.4 kg) from LRFI (n = 10) and high RFI (HRFI, n = 10) lines were randomly selected from the 7th generation of the Iowa State University RFI herd and used in the current study. Sows were fed to appetite from a corn-soy-based diet containing 13.6 MJ/kg metabolizable energy and 172 g/kg crude protein. All sows were milked between 9 and 12 d of lactation; and a fraction of milk was used to determine milk composition. No differences were observed between the lines in milk fat, protein, lactose and gross energy contents and estimated milk production ($P > 0.10$). However, milk saturated fatty acid content (mg/g milk fat) was lower in the LRFI line compared with HRFI (440 vs. 410, ± 10; $P < 0.04$); while unsaturated fatty acid content tended to be higher in the LRFI line (535 vs. 562, ± 11; $P < 0.07$). Relative to HRFI, LRFI sows' milk had higher (mg/g milk fat) conjugated linoleic acid (CLA; 2.3 ± 0.20 vs. 3.2 ± 0.25) contents ($P < 0.05$). Alpha linolenic acid (ALA) content of milk was not different between the lines ($P > 0.01$). Milk ALA to CLA ratio was substantially lower in the LRFI line (2.0 vs. 1.2, ± 015; $P < 0.01$). Collectively, these results provide no evidence that genetic selection for LRFI affects sow milk composition, but that it does alter the sow's milk fatty acid composition. These data suggest that sows selected for LRFI, utilize body reserves more effectively to maintain milk production and composition than HRFI sows. The effects of altered milk fatty acid composition on piglet gut maturation, digestive capacity and health deserves further investigation. Study supported by AFRI grant #2010–40568.

Key Words: residual feed intake, sow, milk composition, fatty acid

45 The effects of N-acetyl-D-glucosamine and a novel N-acetyl-D-glucosamine derivative supplementation on the in vitro production of pig oocytes. L. E. Elsea*, E. Gerken, K. Lemon, R. S. Khupse, and B. D. Whitaker, *University of Findlay, Findlay, OH.*

Objectives were to determine the effects of N-acetyl-D-glucosamine (GlcNAc) and a novel derivative of GlcNAc designed to increase its membrane solubility on the in vitro fertilization (IVF) and embryo development of porcine oocytes. Either GlcNAc or GlcNAc-derivative was supplemented (2.5, 5.0 m*M*) to the media during the last 24 h of oocyte maturation. Matured oocytes (n = 500) were evaluated for zona pellucida and perivitelline space thickness, intracellular levels of glutathione and fertilization success rates at 12 h after IVF. The remaining embryos were cultured and evaluated for cleavage and blastocyst formation at 48 h and 144 h after IVF, respectively. Oocytes supplemented with GlcNAc-derivative had thicker ($P < 0.05$) zona pellucida than those supplemented with GlcNAc. Oocytes not supplemented had a thinner ($P < 0.05$) perivitelline space compared with the other treatments. After maturation there were no significant differences between intracellular glutathione concentrations comparing supplementations. The 5.0 mM GlcNAc-derivative supplemented oocytes were less ($P < 0.05$) penetrated than all other treatments but the non-supplemented oocytes had less ($P < 0.05$) incidence of polyspermic penetration compared with the other supplementations. The 5.0 m*M* GlcNAc-derivative had fewer ($P < 0.05$) oocytes with male nuclear formation than all other treatments and the GlcNAc supplemented oocytes had more ($P < 0.05$) male pronuclear formation than the GlcNAc-derivative supplements. Oocytes that were not supplemented had a higher ($P < 0.05$) percentage of embryos cleaved by 48 h and blastocysts by 144 h after IVF, compared with the supplemented oocytes. These findings suggest that the GlcNAc-derivative supplementation may increase the zona pellucida thickness during maturation but supplementation of 2.5 and 5.0 m*M* GlcNAc or GlcNAc-derivative are not effective in blocking polyspermic penetration or increasing the success of embryo development, despite increasing the perivitelline space thickness.

Key Words: N-acetyl-glucosamine, polyspermy, pigs

46 Relationship of working chute behavior of feedlot cattle to meat quality traits and muscle structure. K. J. Phelps*[1], E. P. Berg[1], N. L. Hall[1], W. L. Keller[1], P. P. Borowicz[1], V. L. Anderson[2], C. A. Schwartz[1], B. R. Ilse[2], J. D. Magolski[1], and K. R. Maddock Carlin[1], *[1]North Dakota State University, Fargo, [2]Carrington Research Extension Center, Carrington, ND.*

The objective was to investigate if the inverse association between working chute behavior and beef tenderness is related to collagen content or sarcomere length. Crossbred steers (n = 183) were blocked by BW (275 ± 38 kg) in a randomized complete block design, allotted to 16 pens, and weighed every 28 d for 195 d. Measures of temperament were exit velocity (EV), chute score (CS), and catch score (CAPS). At 14 to 16 mo of age (606 ± 52 kg), steers were slaughtered. Marbling score, 12th rib fat depth, REA, KPH, and USDA Quality and Yield grades were measured. Strip steaks were collected and aged for 14 d. Shear force (WBSF) and color scores were determined. A portion of LM was collected at 36 h postmortem and analyzed for soluble, insoluble, and total collagen, as well as sarcomere length. Partial correlation

coefficients were determined using MANOVA with the model including breed type. WBSF was negatively correlated ($P < 0.05$) to initial EV (r = −0.20) and average EV (r = −0.15). WBSF was not correlated ($P > 0.5$) to collagen fractions or sarcomere length. Insoluble and total collagen were correlated ($P < 0.05$) to catch score (r = 0.37 and 0.34, respectively) taken during the second weigh period. Soluble collagen tended to correlate ($P = 0.07$) to initial EV (r = 0.33). Additionally, sarcomere length was negatively correlated ($P < 0.05$) to initial EV (r = −0.42). The inverse association between working chute behavior and beef tenderness may be influenced by collagen content or sarcomere length. However, the relationship to WBSF is not evident. Evaluation of the sum of the differences in muscle structure need to be quantified to fully evaluate the relationship between working chute behavior and tenderness.

Key Words: temperament, sarcomere length, collagen

47 Uteroplacental uptake of glucose and fetal liver glycogen in adequately fed or nutrient restricted ewes supplemented with melatonin. M. A. Lein*[1], C. O. Lemley[1], L. E. Camacho[1], A. M. Meyer[2], and K. A. Vonnahme[1], *[1]North Dakota State University, Fargo, [2]University of Wyoming, Laramie.*

Objectives were to examine uteroplacental uptake of glucose and fetal liver glycogen during dietary melatonin supplementation in a maternal nutrient restriction model. From d 50 to 130 of gestation, 31 primiparous ewes were supplemented with 5 mg of melatonin per d (MEL) or no melatonin (CON) and allocated to receive 100% (adequate; ADQ) or 60% (restricted; RES) of nutrient requirements. On d 130 of gestation uterine and umbilical blood flows (BF) were determined via Doppler ultrasonography during a non-survival surgery. Blood samples were collected from the maternal saphenous artery (A), gravid uterine vein (V), umbilical artery (a), and umbilical vein (v) for glucose analysis. Uterine flux ([A-V] x uterine BF), fetal flux ([v-a] x umbilical BF), and uteroplacental flux (uterine flux - fetal flux) of glucose (mg/min) were calculated. Fetal livers were collected for glycogen analysis. Maternal artery glucose concentrations tended ($P = 0.09$) to be increased in MEL vs. CON dams, while uterine vein concentrations were not different ($P > 0.2$). Umbilical vein glucose was decreased ($P < 0.01$) in RES vs. ADQ dams, while umbilical artery glucose showed a nutritional plane by melatonin supplementation interaction ($P < 0.02$), where MEL-RES was decreased ($P \leq 0.05$) vs. all others. Maternal AV difference tended ($P = 0.06$) to be increased in RES vs. ADQ dams, while fetal va difference was decreased ($P \leq 0.05$) in RES vs. ADQ. Uterine consumption of glucose showed a tendency ($P < 0.08$) for a nutritional plane by melatonin supplementation interaction, where MEL-RES was increased ($P < 0.05$) vs. all others. Fetal consumption of glucose tended ($P < 0.07$) to be decreased in RES vs. ADQ, although uteroplacental consumption of glucose increased ($P < 0.05$) in RES vs. ADQ dams. Fetal liver glycogen concentration was not different ($P > 0.1$) between groups, whereas total liver glycogen decreased ($P \leq 0.05$) in RES vs. ADQ fetuses. Maternal nutrient restriction increased uteroplacental uptake of glucose; however, fetal glucose consumption and total fetal liver glycogen were decreased in nutrient restricted dams.

Key Words: fetal glycogen, glucose flux, utero-placenta

48 Sorting by parity improves welfare and performance of young sows in a group-housing gestation system. Y. Z. Li*, L. H. Wang, L. J. Johnston, A. M. Hilbrands, and X. L. Xie, *West Central Research and Outreach Center, University of Minnesota, Morris.*

Young sows usually lose most fights and suffer more injuries than mature sows at mixing in group-housing systems. We hypothesized that sorting by parity will reduce aggression and associated stress, and thereby improve welfare and performance of first parity sows in a group housing system. Sows and gilts (n = 180) from 6 breeding groups were used. Within each group, 2 groups of 15 females were mixed in each of 2 treatment pens after weaning, and remained there throughout the entire gestation period. The control pen consisted of 11 multiparous and 4 first parity sows; and the treatment pen consisted of 11 gilts and 4 first parity sows. Injury scores were assessed before and 48 h after mixing for all females. Aggressive interactions involving first parity sows were video-recorded for 72 h immediately after mixing in each pen. Data were analyzed using the Glimmix procedure. All females in treatment pens sustained fewer scratches (P = 0.01) 48 h after mixing than females in control pens. First parity sows in treatment pens fought more frequently (9.0 vs. 5.7 fight/h, SE = 1.05; P = 0.01) and tended to fight for longer periods (67 vs. 30 s/h, SE = 19.4; P = 0.08), and won more fights involving parallel pressing (46% vs. 18%, SE = 14.1%; P = 0.04), but had lower injury scores (8.0 vs. 12.6, SE = 1.53; P = 0.03) after mixing, gained more weight (57 vs. 33 kg, SE = 7.3; P < 0.01) during gestation, and had higher farrowing rates (94% vs. 67%, Chi-squared = 4.75; P = 0.03) compared with first parity sows in control pens. These data suggest that sorting by parity shields first parity sows from severe aggression-induced injuries so that their welfare and performance is improved in group housing systems.

Key Words: aggression, sows, gestation housing, parity

49 The sow body condition caliper—A new, objective tool. M. T. Knauer*[1], K. J. Stalder[2], D. Baitinger[3], and D. C. Kendall[4], *[1]North Carolina State University, Raleigh, [2]Iowa State University, Ames, [3]Baitinger Engineering, Ankeny, IA, [4]Prestage Farms, Clinton, NC.*

Cost effective, objective measures of sow body condition are needed to reduce feed costs, improve productivity and maximize sow well-being. Therefore, the study's objective was to estimate the relationship between body composition and a new tool developed to assess sow body condition. Composite Landrace × Large White gilts and multiparous sows (n = 150) were measured at a commercial farm in eastern North Carolina. A prototype caliper was developed to quantify the angularity of a sow's topline. Measurements with the caliper were taken across the back at the last rib. Backfat (BF) and loin depth (LD) were measured from a 10th rib cross-sectional image by a real-time ultrasound technician. Sow weight was estimated from heart girth circumference and parity was recorded. Visual body condition was scored on a 1 to 5 scale by the farm staff (FarmBCS) and an individual with extensive livestock evaluation experience (BCS). Data were analyzed in SAS using PROC CORR and PROC GLM. Means (±SD) for BF, LD, weight, parity, FarmBCS, BCS and caliper were 2.9 ± 0.73 cm, 5.2 ± 0.55 cm, 248 ± 35 kg, 3.4 ± 2.9, 3.17 ± 0.50, 3.37 ± 0.68 and 21.5 ± 2.5, respectively. Backfat was phenotypically correlated (P < 0.01) with weight, FarmBCS, BCS and the caliper (0.34, 0.44, 0.63 and −0.60, respectively). However, correlations between BF with LD and parity (0.06 and 0.01, respectively) were not significant. Loin depth was correlated (P < 0.01) with weight, parity, FarmBCS, BCS and the caliper (0.46, 0.29, 0.38, 0.30 and −0.45, respectively). The caliper was correlated with weight (r = −0.45, P < 0.01) but not parity (r = −0.07, P > 0.05). Backfat had a quadratic (P < 0.01) relationship with the caliper. As backfat decreased, the association between BF and the caliper increased. Backfat and LD explained significant variation in weight, FarmBCS, BCS and the caliper (R2 = 0.31, 0.32, 0.47 and 0.56, respectively). The sow body condition caliper is an objective tool that was more accurate in assessing body composition than visual body condition scores.

Key Words: backfat, body condition, sow

50 The effect of morbidity on longissimus muscle area and subcutaneous and intramuscular adipose deposition in feedlot steers. K. M. Thompson[1], J. J. Wagner*[1], C. M. McAllister[1], B. W. Brigham[1], R. K. Peel[1], H. Van Campen[2], G. H. Loneragan[3], R. L. Weaber[4], J. L. Salam-Johnson[5], and C. C. L. Chase[6], *[1]Department of Animal Science, Colorado State University, Fort Collins, [2]Department of Microbiology, Immunology, and Pathology, Colorado State University, Fort Collins, [3]Department of Animal and Food Sciences, Texas Tech University, Lubbock, [4]Department of Animal Science and Industry, Kansas State University, Manhattan, [5]Department of Animal Science, University of Illinois, Urbana, [6]Department of Veterinary and Biomedical Sciences, South Dakota State University, Brookings.*

Cross-bred steers (n = 1,233) were used to evaluate the impact of morbidity on LM area (LMA) and subcutaneous (BF) and intramuscular (MARB) adipose accretion during a 237 d feeding period. Steers were blocked by arrival date, housed in pens of about 200 at a commercial feedlot, and fed a steam-flaked corn-based finish diet. Body weight and ultrasound measurements of LMA, BF, and MARB accretion rates were obtained on d 0, 100, and 170. On d 237, steers were transported to a commercial abattoir, slaughtered, and carcass data were obtained. For data analysis, cattle were assigned to one of 2 groups: 1) non-treated (no medical treatments) or 2) treated (treated for any medical reason). A total of 94 steers were treated (n = 76, treated before d 100; n = 11, treated between d 100 and 170; and n = 7, treated from d 170 to end of study). Treated steers had lower LMA (P < 0.02), BF (P < 0.0001) and MARB (P < 0.001) accretion rates, and BW gain (P < 0.0001) vs. non-treated steers. To achieve similar BF (1.27 cm), MARB (Small^{00} which is indicative of low Choice), or BW (552 kg) at slaughter, treated steers need to remain on feed for 16, 26, or 20 additional d as compared with non-treated steers, respectively. Although LMA accretion rate was related to health status, prediction equations indicate treated cattle achieved similar endpoint LMA as non-treated cattle.

Key Words: carcass merit, health status, ultrasound, harvest end-point

51 Willingness to approach (WTA): Live human observation and digital image. S. L. Weimer*[1], A. K. Johnson[1], K. J. Stalder[1], L. A. Karriker[1], and T. J. Fangman[2], *[1]Iowa State University, Ames, [2]Boehringer Ingelheim Vetmedica, Ames, IA.*

The US swine industry has struggled with the inclusion of a repeatable and objective behavioral tool for on farm assessments that quantifies how a pig is coping when exposed to potential stressors. The objective of this study was to compare live human observation and digital image methodologies when evaluating nursery pig behaviors. Nursery

pig behavior was evaluated on commercial nursery pens (n = 79 pens, ~23 pigs/pen aged 6 wk) using the Swine Welfare Assurance Program protocol. Two treatments were compared: live human observer and digital image evaluation. The observer entered the front of the pen and crouched, looking at the ground for a 15 s acclimation period. At the conclusion of the acclimation period, the observer raised her head, took a digital image using the wireless remote and simultaneously scanned the nursery pen to record 3 behaviors: WTA defined as any part of the pigs' body touching the human observer, look defined as eye contact (both eyes) with the observer and not defined as pigs not previously classified as WTA or look. The experimental unit was the pen of pigs. Data were analyzed using the PROC GLIMMIX procedure of SAS. There were no ($P = 0.11$) differences between the methods when classifying pigs as WTA (1.80 ± 0.57 H vs. 2.14 ± 0.68 D). There were differences between methods with fewer ($P < 0.0001$) pigs being classified as look for H (6.33 ± 0.34 pigs) vs. D (8.30 ± 0.41) and more ($P < 0.0001$) pigs being classified as not for H (12.13 ± 0.78) vs. D (14.46 ± 0.90) respectively. Hence, either nursery pig behavior evaluation method could be used to determine the number or proportion of pigs exhibiting WTA. However, the digital image method is more precise for look and not behaviors when compared with live human observation. Further work on the WTA evaluation methodology under different circumstances and with pigs differing in age needs to be conducted.

Key Words: behavior, swine, willingness to approach

52 Behavioral response of nursery pigs to reduced nocturnal temperature. Y. Z. Li*, L. H. Wang, L. J. Johnston, A. M. Hilbrands, and X. L. Xie, *West Central Research and Outreach Center, University of Minnesota, Morris.*

Nursery pigs are housed within their thermoneutral zone without diurnal variation to minimize cold stress. However, previous studies suggested that nursery pigs prefer lower environmental temperatures at night compared with day. Reducing nocturnal temperature in nursery barns may not jeopardize welfare of pigs and can save fuel needed to heat the barn. A study was conducted in 4 replicates to investigate behavioral response of nursery pigs in a reduced nocturnal temperature (RNT) regimen. In each replicate, 2 identical rooms were assigned to either control or RNT. In the control room (CON), temperatures were maintained at 25.2 ± 0.3°C constantly. In RNT, temperatures were the same as in CON during daytime (0800 h to 2000 h), but reduced to 21.8 ± 0.41°C during nighttime (2000 h to 0800 h). Three days after exposure to the experimental temperatures, 6 pens (9 pigs/pen, BW = 7.9 ± 0.96 kg) in each room were video-recorded for 24 h. Two focal pigs in each pen were watched for 10 min every hour for 24 h of the recording period to register duration and occurrence of eating and drinking. Data were analyzed using the Proc Glimmix of SAS with pen as the experimental unit. Eating and drinking behavior of pigs was not affected by temperature treatment. Pigs in both CON and RNT rooms ate for longer periods (427 vs. 166 $s \cdot pig^{-1} \cdot h^{-1}$, SE = 25.8; $P < 0.01$) and more frequently (1.8 vs. 0.6 $times \cdot pig^{-1} \cdot h^{-1}$, SE = 0.11; $P < 0.01$) during daytime compared with night. Similarly, pigs drank for longer periods (28 vs. 7 $s \cdot pig^{-1} \cdot h^{-1}$, SE = 2.5; $P < 0.01$) and more frequently (1.6 vs. 0.5 $times \cdot pig^{-1} \cdot h^{-1}$, SE = 0.09; $P < 0.01$) during daytime compared with night. There were no interactions between room temperature and time of day for eating or drinking behaviors. These data suggest that reducing nocturnal temperature by 4°C does not jeopardize welfare of nursery pigs.

Key Words: behavior, pigs, nocturnal temperature, eating

53 Reducing energy consumption in swine nurseries with reduced nocturnal temperature (RNT). L. J. Johnston*[1], M. C. Brumm[2], S. Moeller[3], S. Pohl[4], M. Shannon[5], and R. Thaler[4], *[1]University of Minnesota, West Central Research and Outreach Center, Morris, [2]Brumm Swine Consultancy, Mankato, MN, [3]The Ohio State University, Columbus, [4]South Dakota State University, Brookings, [5]University of Missouri, Columbia.*

Swine nursery barns in 4 states were used to determine if reducing room temperature at night could reduce fossil fuel consumption without compromising pig growth performance. Each trial lasted 28 to 42 d with each station completing at least 2 replicate trials during winter and early spring using 2 identical nursery rooms in each replicate. In control rooms (CON; n = 9), temperature controllers were set at 30°C for the first wk and reduced by 2°C/wk during the remainder of the trial. Day- and night-time temperature settings were the same in CON rooms. In the RNT rooms (n = 10), temperature controllers were set at 30°C for the first 4 d after arrival of pigs. Beginning on d 5, daytime furnace temperature and fan control settings were equal in CON and RNT rooms; however, between 1900 and 0700 h, furnace set point was reduced 8.3°C with ventilation controls maintained at daytime settings. Daytime temperature in the RNT room was also reduced 2°C/wk during the remainder of the study. Each room was independently monitored for consumption of propane or natural gas and electricity. Weight gain and feed consumption of pigs were recorded on a room basis as was use of fossil fuels. Neither final pig weight (21.7 vs. 21.5 kg; PSE = 0.64), ADG (0.45 vs. 0.44 kg; PSE = 0.016), ADFI (0.61 vs. 0.60 kg; PSE = 0.019) nor G:F (0.75 vs. 0.75; PSE = 0.012) were different for pigs housed in CON or RNT rooms, respectively. Likewise, pig mortality (1.5% vs. 1.2%) was not different for pigs in CON and RNT rooms, respectively. Consumption of heating fuel and electricity was consistently reduced in RNT rooms for all 4 stations. Consumption of heating fuel (7,061 vs. 10,019 Btu/pig-day; PSE = 1,467) and electricity (0.021 vs. 0.026 KWH/pig-day; PSE = 0.004) were lower ($P < 0.05$) in the RNT rooms compared with CON rooms. On average, we documented a 29% reduction in heating fuel use and a 19% reduction in electrical use with no differences in pig growth performance or health. From these data, we conclude that a RNT regimen is effective in reducing energy costs in the nursery without compromising pig performance.

Key Words: energy use, room temperature, reduced nocturnal temperature, pigs

54 Using vaginal temperature as an indicator of heat stress in free-ranging dairy animals. M. J. Brouk*, J. F. Smith, and J. P. Harner, *Kansas State University, Manhattan.*

During heat stress, environmental conditions may contribute to total body heat load and limit the ability of dairy cows to exchange heat to the environment. As a result, body temperature will rise, reducing production and increasing stress. The level of heat stress experienced by dairy cattle may vary in different facilities and under different types of heat abatement systems. A system utilizing data loggers (model HOBO U12) from Onset Computer Corporation (Pocasset, MA) has been utilized in many experiments and farm evaluations to determine the degree of heat stress experienced by free-ranging dairy animals over a period of 1–5 d. Systematic evaluation of the data has been effective in determining the effect of cooling treatments on vaginal temperature and its relationship to body temperature. The devices were set to record vaginal temperature at 1-min intervals and the data was averaged into 5-min periods and graphed over a 24-h period. In trial 1, 16 lactating

Holstein cows were allotted in a double-switchback design in groups of 4 animals to each of 4 pens located in 2-row freestall barns to evaluate using feed line soakers with 2 different modes of operation. In both modes, the minimal barn temperature for operation was set at 23.9°C and animals were soaked for 1 min with a soaking interval of 14 min. The 2-stage treatment decreased the soaking interval to 4 min when the barn temperature reached 29.4°C and the linear treatment decreased the interval between soakings at a rate of 0.9 min for each 1°C rise in barn temperature up to 35°C at which point the soaking interval was 4 min. Body temperatures were similar ($P = 0.7$) for both treatments. In trial 2, 16 lactating Holstein cows were as described in trial one in a Latin square design to evaluate the minimal barn temperature for feed line soaker system operation. Minimal operation temperatures were 18.3, 21.1, 23.9, and 26.7°C. Vaginal temperatures were similar ($P = 0.35$) between treatments suggesting that a higher minimal operational temperature could be utilized to reduce water consumption.

55 Identification and evaluation of quantitative trait loci influencing growth, carcass composition, and meat quality traits in pigs. I. Choi*, J. P. Steibel, R. O. Bates, N. E. Raney, and C. W. Ernst, *Michigan State University, East Lansing.*

Quantitative trait loci (QTL) mapping has identified genomic regions controlling phenotypic variation for numerous pig traits. The objectives of this research were to 1) apply alternative models to identify QTL for growth, carcass and meat quality traits in the MSU F_2 Duroc × Pietrain resource population and 2) conduct a validation study of selected QTL regions in a commercial Duroc population. Based on an initial genome scan using 510 F_2 pigs with 124 microsatellite markers, 20 additional markers on 9 chromosomes were genotyped for 954 F_2 pigs and 20 markers used in the first scan were genotyped for 444 additional F_2 pigs. Three least-squares models, line-cross (LC), half-sib (HS), and combined line-cross and half-sib (CB), were applied to identify QTL segregating between and within parental breeds. A total of 41 QTL for growth traits were identified (FDR ≤0.05). The LC analysis revealed 26 QTL, including 7 new QTL (SSC7, 15 and 18). The HS analysis revealed 12 QTL, and 3 additional QTL were detected using the CB model. A total of 91 QTL for carcass and meat quality traits were identified (FDR ≤0.05). The LC analysis revealed 50 QTL including 14 new QTL (SSC3, 6, 7, 12, 16 and 18). The HS analysis revealed 38 QTL, and 3 additional QTL were detected using the CB model. Based on these results, 5 putative QTL regions (SSC3, 6, 12, 15 and 18) for carcass and meat quality traits were selected for further evaluation in a purebred Duroc population. A total of 81 gene-specific single-nucleotide polymorphisms (SNP) were genotyped of which 33 were segregating and were analyzed for associations with pH, color and marbling, and age, backfat thickness and LMA adjusted to 113 kg. Significant associations were observed with pH, marbling score and L* ($P \leq 0.05$), which were consistent with the genome scans. Identification and subsequent validation of QTL influencing growth, carcass composition and meat quality traits in resource and commercial populations will facilitate successful implementation of marker assisted selection programs to achieve genetic improvement.

Key Words: pig, QTL, meat quality

56 Comparison of three methods for tagSNP selection. Y. M. Badke*[1], R. O. Bates[1], C. W. Ernst[1], and J. P. Steibel[1,2], *[1]Michigan State University, Department of Animal Science, East Lansing, [2]Michigan State University, Department of Fisheries & Wildlife, East Lansing.*

High density genotypes from single nucleotide polymorphisms (SNP) are available for a variety of livestock species. To improve cost efficiency of genomic selection, a maximally informative subset of SNP (tagSNP) can be used to impute all remaining SNP. Our objective was to compare imputation accuracy of unobserved SNP genotypes ascertained using tagSNP resulting from 3 selection procedures: 1) evenly-spaced markers 2) applying statistical criteria based on minimum pairwise Linkage Disequilibrium (LD) and 3) using predictive ability. We simulated genotypes (M = 1578 SNP on one chromosome, 25 cM) for 60 samples as a reference panel and 200 validation samples. Average imputation accuracy was calculated as the mean difference between observed and predicted allelic dosage. Evenly spaced SNP were selected based on their map position. The tagSNP selected based on minimum pairwise LD were chosen such that each SNP was either a tagSNP or in LD higher than a given threshold with a tagSNP. For the predictive method the SNP causing the highest increase in average imputation accuracy was added as a tagSNP using a forward selection algorithm. A set of 30 tagSNP was selected based on minimum pairwise LD (threshold $r^2 = 0.3$), therefore 30 tagSNP were also selected applying the other 2 methods. The minimum pairwise LD approach resulted in a validation imputation accuracy of 0.96 ± 0.03 compared with 0.97 ± 0.02 using the tagSNP selected for their predictive ability, while evenly spaced SNP yielded imputation accuracy of 0.91 ± 0.04. All methods resulted in imputation accuracy significantly higher than that of randomly selected markers (0.80 ± 0.02). To achieve imputation accuracy of 0.96 using evenly spaced SNP, a total of 41 tagSNP (0.96 ± 0.03) was necessary. If LD information is available and used for tagSNP selection, either directly (minimum pairwise LD tagSNP selection) or indirectly (predictive selection), the resulting panel consistently yields imputation accuracy higher than that of an evenly spaced marker panel. These results are crucial to many livestock industries that estimate genomic breeding values from imputed high-density genotypes.

Key Words: tagSNP selection, genotype imputation, imputation accuracy

57 Genetic parameters for feed consumption, feed conversion ratio and residual feed intake in laying hens. A. Wolc*[1,2], J. Arango[3], P. Settar[3], J. E. Fulton[3], N. P. O'Sullivan[3], and J. C. M. Dekkers[2], *[1]Department of Genetics and Animal Breeding, Poznan University of Life Sciences, Poznan, Poland, [2]Department of Animal Science and Center for Integrated Animal Genomics, Iowa State University, Ames, [3]Hy-Line International, Dallas Center, IA.*

Efficiency of production is increasingly important with the current rise of feed costs and the interest to minimize environmental footprints. The objective of this study was to estimate heritability and genetic correlations for average feed consumption (AFC), feed conversion ratio (FCR) and residual feed intake (RFI) with production and egg quality traits in a brown egg layer line. AFC was measured as an average over 2 weeks for 4431 birds from 6 generations. FCR was defined as the ratio of AFC to egg mass and RFI was calculated as residuals from regression of AFC on egg mass and metabolic body weight. Genetic parameters were estimated with multi-trait animal model using ASReml (Gilmour et al., 2008). Estimates of heritability were 0.39, 0.04 and 0.33 for AFC, FCR and RFI. The low heritability of FCR may be attributed to its definition as a ratio which caused severe skewness compared with the other 2 feed consumption related traits. Phenotypic correlations among feed consumption traits were 0.20 for AFC-FCR, 0.74 for AFC-RFI and 0.24 for RFI-FCR; respective genetic correlations were 0.73, 0.91 and 0.94. Estimates of genetic correlations between AFC,FCR, RFI and egg production and quality traits showed that hens which consumed more feed and that had higher RFI tended to lay larger eggs ($r_G = 0.36$ and 0.16) with higher yolk weight ($r_G = 0.46$ and 0.33) and albumen height ($r_G = 0.24$ and 0.19), but lower shell quality ($r_G = -0.21$ and -0.12). FCR was positively correlated with shell quality ($r_G = 0.51$) and yolk weight ($r_G = 0.13$) but negatively with egg production ($r_G = -0.27$) and albumen height ($r_G = -0.13$). In conclusion, FCR seems to be less suitable trait for selection than AFC and RFI.

Key Words: feed efficiency, laying hens, heritability

58 Genetic architecture of response to experimental porcine reproductive and respiratory syndrome virus infection. N. J. Boddicker*[1], D. J. Garrick[1], J. M. Reecy[1], R. R. R. Rowland[2], J. K. Lunney[3], and J. C. M. Dekkers[1], *[1]Iowa State University, Ames, [2]Kansas State University, Manhattan, [3]USDA, ARS, BARC, Beltsville, MD.*

Understanding the genetic architecture of complex disease traits, such as porcine reproductive and respiratory syndrome (PRRS), is important in the improvement of animal health. The objective of this study was to find chromosomal regions in the host that are associated with PRRS resistance and to quantify the contribution of each region using data from the PRRS Host Genetics Consortium PRRS-CAP project. Five groups of 200 commercial crossbred pigs, from 3 genetics companies, were infected between 18 and 28 d of age with virus isolate NVSL 97–7985. Blood samples and body weights were collected up to 42 d post infection (dpi). Pigs were genotyped with the Illumina Porcine 60k Beadchip. Whole genome analyses focused on viral load (VL = area under the curve for log-transformed RT-PCR based serum virus from 0 to 21 dpi) and weight gain (WG = gain from 0 to 42 dpi). Using Bayesian variable selection model Bayes-CPi, which estimates the proportion of SNP with zero effect, pi, the posterior mean of pi was 0.997 for VL and 0.999 for WG. Therefore, of the 58,277 markers in the analysis, sets of only 175 SNP were required to represent genomic association with VL and 59 SNP with WG. Using Bayes-B with pi estimated from Bayes-CPi, 8 1-Mb regions, each explaining at least 1% of the genetic variance, collectively accounted for 35.7% of the genetic variance for VL, with the largest region on chromosome 4 explaining 17.7%. For WG, 10 regions collectively accounted for 31.2% of genetic variance, with the largest region on chromosome 4 accounting for 14.3%. In conclusion, a limited number of genomic regions account for a substantial percentage of the host genetic variance associated with PRRS resistance. Although disease resistance is a polygenic trait, genetic improvement of host resistance can be achieved by focusing on a select few SNP. This work was supported by the PRRS CAP, USDA NIFA Award 2008–55620–19132, the NRSP-8 Swine Genome and Bioinformatics coordination projects, the National Pork Board, and the breeding companies involved in the PRRS Host Genetics Consortium that provided pigs.

Key Words: swine, PRRS, GWAS, SNP

59 Relationship between purebred and crossbred performance for number born alive and number born dead. C. Abell*[1], K. Stalder[1], and J. Holl[2], *[1]Iowa State University, Ames, [2]Smithfield Premium Genetics Group, Rose Hill, NC.*

The breeding objective for a swine nucleus selection program is to improve crossbred commercial performance. Most genetic improvement programs are based on an assumed relationship between purebred performance in a nucleus herd and their relatives' crossbred performance in a commercial herd. Since nucleus animals have fewer parities to shorten the generation interval and the importance of longevity at the commercial level, it is important to analyze the relationship between purebred parity 1 performance and crossbred parity 2 and greater performance. The objective of this study was to examine the relationship between purebred and crossbred reproductive performance using number born alive and number born dead as the reproductive traits of interest. For this analysis, 28,542 records from 11,506 purebred sows and 49,475 records from 12,897 crossbred sows were evaluated. Purebred sows were from Landrace and Large White pure lines, and the crossbred sows were F1 offspring from a cross between the 2 pure lines. Number born alive and number born dead records from parity 1 one were considered to be different traits than records from parities 2 and greater. A model for the parity 1 traits included age at first farrowing as a linear covariate and contemporary group and breed as a fixed effects. The fixed effects for the parity 2 and greater traits included parity and contemporary groups. All models included a random animal effect and a permanent environment effect was fitted for the repeated records. Variance component estimates and correlations were calculated using ASREML (VSN International, Hemel Hempstead, UK). The heritability estimates for all traits ranged from 0.11 to 0.22. The estimated genetic correlations (standard error) for NBA and NBD between the first parity at the nucleus level and parities 2 and greater at the commercial level were 0.98 (±0.20) and 0.40 (±0.22), respectively. Based on these results, it is possible to make substantial genetic improvement in crossbred performance when selection is only on purebred performance.

Key Words: swine, reproductive performance, genetic correlation, number born alive

60 Identification of genomic regions affecting body weight and hen house production using genomic prediction methods in broiler chickens. C. Wang*[1], D. Habier[1], L. Peiris[1], A. Wolc[1], A. Kranis[2], K. A. Watson[2], S.Avendano[2], D. J. Garrick[1], R. L. Fernando[1], S. J. Lamont[1], and J. C. M. Dekkers[1], *[1]Department of Animal Science, Iowa State University, Ames, [2]Aviagen Ltd., Newbridge, Midlothian, UK.*

Genomic prediction methods based on high density (HD) marker panels can be used not only to estimate genomic EBVs but also to identify genomic regions affecting traits. In this study, 1,259 birds from 4 generations of a commercial broiler breeding line were genotyped with a custom HD marker panel including 36,455 SNPs. After quality edits, 20,541 segregating SNPs were kept for analysis. Two traits, body weight (BW) with heritability 0.27, and hen house production (HHP) with heritability 0.16 were analyzed. Both own performance and progeny means of genotyped individuals were used as phenotypes. The number of records was 2,749 (including 1,259 individual performances, 848 full-sib family means and 642 half-sib family means) for BW and 1,773 (including 861 individual performances, 641 full-sib family means and 271 half-sib family means) for HHP. Bayes-CPi of GenSel 4.0 was first used to estimate the proportion of SNP with zero effects (Pi) as 0.96 for BW and 0.98 for HHP. Then, Bayes-B with the previously estimated Pi was used to estimate marker effects. The proportion of genetic variance explained by each 1 Mb window was calculated to identify the important genomic regions for the trait. For BW, the largest window variance was 1.75% from Bayes-B. For HHP, the largest window variance was 2.02% from Bayes-B. Results show that both traits are highly polygenic, with no major QTL. Funding from Aviagen Ltd. and SABRE Demonstration Funds of EU Framework 7.

Key Words: important genome regions, genomic selection, broiler chickens

61 Genetic parameters for growth performance and residual feed intake in a commercial line of Duroc pigs. D. M. Thekkoot*[1], R. A. Kemp[2], and J. C. M. Dekkers[1], *[1]Iowa State University, Ames, [2]Genesus Genetics Inc., Canada.*

Residual feed intake (RFI) is a measure of feed efficiency which represents the fraction of total feed intake which is not explained by the average production and maintenance requirements. The data for this study were from a purebred Duroc line provided by Genesus Genetics Inc. (Canada). The aim of this study was to estimate genetic param-

eters for RFI and related production traits. All the recordings were made by the company staff as a part of their routine selection procedures between 2004 and September 2010. Individual feed intake (FI) of group housed growing pigs were recorded using IVOG feeding system. Piglets were placed on test at ~75 d of age for ~100 d. Pigs were weighed up to 5 times during the test period. Backfat(BF) depth was recorded by ultrasound equipment at ~100 kg body weight. The complete pedigree information available was utilized for the analysis. The final edited data set consisted of 3499 boars and 851 gilts with complete information for FI, body weight, BF and pedigree. For each pig, average daily gain(ADG) was estimated as the slope from the linear regression of body weight on age. ADG was preadjusted for on-test age and used for estimating parameters. Similarly, BF was adjusted for ultrasound technician, machine type and body weight. Genetic parameters were estimated by single trait linear mixed model analyses using ASReml. Fixed effects included in the model were pen (207 levels), sex (2 levels) and year-season (17 levels). The interaction of year-season with adjusted ADG, adjusted BF, age at the beginning and end of test, weight at the beginning and end of test and age at first weight were included as covariates in the model. The animal genetics and litter effects were included as random effects in all models. Heritability estimates for RFI, average daily feed intake (ADFI), BF and ADG were 0.22(±0.04), 0.22(±0.05), 0.31(±0.05) and 0.18(±0.04) respectively. Litter effects accounted for 7.8 and 9.7% of phenotypic variation for RFI and ADFI. Results shows that for the population studied, selection based on intake-based indicators can result in reasonable genetic improvement for feed efficiency.

Key Words: residual feed intake, pig, heritability

62 Discovering regions of the bovine genome associated with variation in the immune response. R. J. Leach*[1,2], E. J. Glass[2], and L. A. Kuehn[1], *[1]USDA-ARS, US Meat Animal Research Center, Clay Center, NE, [2]The Roslin Institute and Royal (Dick) School of Veterinary Studies, University of Edinburgh, Easter Bush, Midlothian, UK.*

Infectious disease of livestock continues to be a cause of substantial economic loss and adverse welfare. Breeding for disease resistant livestock could improve both the economic burden and animal welfare. Using genetic linkage and association methods, we aim to identify key genes and pathways that control variation in immune response; knowledge that may aid both breeders and vaccinologists. The second generation of the RoBoGen herd (a Charolais Holstein F_2 backcross, n = 982) were phenotyped for immune responses (total IgG responses) to a Bovine Respiratory Syncytial Virus (BRSV) vaccine (n = 467) across several time points. Considerable variance in immune responses enabled detection of QTL using 165 equally spaced microsatellite markers genotyped genome wide. Further genotyping of the F2 animals in these regions using non-synonymous SNP (n = 274) increased resolution to detect linkage disequilibrium associations. A genome wide association study which used the SNP indicated that several regions of the bovine genome play a significant role throughout the immune response to the BRSV vaccine. A second population (MARC III, a composite population, n = 3500) have been vaccinated for BRSV, PI3, BVDV and IBR. Immune phenotypes, such as IgG and lung score, have been measured. Every animal in the herd is also genotyped with at least 50K SNPs. Using both herds, regions associated with the immune response have been discovered and genetic variance components have been estimated. Regions such as the major histocompatibility complex (MHC) on chromosome 23 and the cluster of toll-like receptors (TLRs 1, 6, and 10) on chromosome 6 have been highlighted. We conclude that key pivotal pathways may be shared in eliciting and maintaining an immune response to differing types of antigens.

Key Words: immune response, beef cattle, genetic markers, vaccination

63 Evaluation of the effect of number after transfer on litter weaning weight, mean pig weaning weight, survival and number weaned. R. L. Cutshaw*[1], A. P. Schinckel[1], J. Fix[2], and C. Schwab[2], *[1]Purdue University, West Lafayette, IN, [2]National Swine Registry, West Lafayette, IN.*

The purpose of study was to evaluate the relationships of number after transfer (NAT) with litter weaning weight (LWW), number weaned (NW), mean pig weight (PWT), and survival (%S). Data consisted of 75,482 litters from Yorkshire and Landrace purebred sows and was distributed into 3 time classes with 26,105 parity records from 1980 to 1999, 40,015 for 2000 to 2009, and 9,362 for 2010 to 2011. The data was truncated to: sows with 1–10 parities, NAT = 6–16 pigs and weaning age = 12–32d. The interactions of NAT and production measures were analyzed and compared. The LWW, %S, NW, and PWT data were fitted to a model including fixed effects of weaning age, farm ID, breed, parity, NAT, and all 2-way interactions with sow and litter ID added as random effects. Preliminary analyses indicated that the relationships between NAT and LWW differed by time periods with maximum LWW (65.35kg at NAT = 12 for period 1, 68.27kg at NAT = 13 for period 2, and 70.18kg at NAT = 13 for period 3($P < 0.001$)), which were 3.9, 6.4, and 8.6kg greater than the LWWs achieved at NAT = 10 for each time period. The PWTs decreased as the number after transfer increased. The PWTs for NAT = 14 were 0.918, 0.930, and 0.940 as great as when NAT = 10. Overall, %S decreased in a linear fashion from 6 to 12 NAT then decreased at an increasing rate as NAT increased above 12. The NW increased in a linear fashion up to NAT = 11 then increased at a decreasing rate to a maximum value of NAT = 14. As NAT increased above 14 the NW did not increase, but slightly decreased. There were no significant ($P > 0.05$) parity by period interactions. National Swine Improvement Federation (NSIF, 1997) adjustment factors suggest that there is no increase in LWW for litters exceeding 10 pigs NAT. These results suggest that the effects of NAT from 10 to 14 for LWW and for PWT have changed over time. Furthermore, the data suggest that the relationships between NAT and measures of sow productivity should be periodically re-estimated.

Key Words: sow productivity, adjustment, litter weaning weight, number weaned

64 Estimation of genetic parameters for behavioral assessment scores in Labrador Retrievers. K. M. Schiefelbein*[1], D. W. Moser[1], J. M. Bormann[1], and E. A. Leighton[2], *[1]Kansas State University, Manhattan, [2]The Seeing Eye Inc., Morristown, NJ.*

Temperament is the primary cause for disqualification of potential guide dogs for the visually impaired persons. The objective of this study was to estimate heritability of leading factors measured by the Canine Behavioral Assessment and Research Questionnaire (CBARQ). The CBARQ is a standardized questionnaire that contains 7 behavioral categories: training and obedience, aggression (AGG), fear and anxiety, separation-related behavior, excitability, attachment and attention-seeking, and a miscellaneous category. These categories and questions allow the evaluator to describe any dog's behavior. For this study, questionnaires were obtained at 6- and 12 mo of age. CBARQ scores were collected on 989 6-mo-old and 1,187 12-mo-

old Labrador Retrievers. A pedigree file of 15,141 animals and the data were obtained from a closed breeding colony at The Seeing Eye Inc. Heritability was estimated with a Restricted Maximum Likelihood procedure using a single trait animal model with sex as a fixed effect. Estimates of direct h^2 and SE for each subscale at 6- and 12 mo, respectively, were: stranger-directed AGG 0.13 (0.07) and 0.09 (0.05), owner-directed AGG 0.07 (0.04) and 0.08 (0.05), unfamiliar dog-directed AGG 0.05 (0.06) and 0.03 (0.04), familiar dog-directed AGG 0.00 (0.04) and 0.05 (0.04), trainability 0.09 (0.05) and 0.46 (0.07), chasing 0.04 (0.06) and 0.07 (0.04), stranger-directed fear 0.00 (0.03) and 0.02 (0.02), nonsocial fear 0.01 (0.03) and 0.07 (0.04), separation-related problems 0.06 (0.04) and 0.08 (0.04), pain sensitivity 0.07 (0.05) and 0.10 (0.05), excitability 0.04 (0.04) and 0.08 (0.05), and attachment/attention-seeking 0.03 (0.03) and 0.13 (0.05). In general, the factors were lowly heritable. Trainability, however, was found to be highly heritable at 12 mo of age, thus selection pressure applied using this variable could produce genetic improvement. These estimates are useful to understand more about the nature of behavioral traits leading to the production of successful working guides.

Key Words: heritability, guide dogs, behavior

65 Analysis of candidate gene SNP on piglet response to experimental infection with PRRSv. E. H. Waide*[1], N. Boddicker[1], Z. Jiang[2], J. J. Michal[2], R. Rowland[3], J. K. Lunney[4], and J. C. M. Dekkers[1], *[1]Iowa State University, Ames, [2]Washington State University, Pullman, [3]Kansas State University, Manhattan, [4]USDA, ARS, BARC, Beltsville, MD.*

The economic impact of porcine reproductive and respiratory syndrome virus (PRRSv) emphasizes the importance of developing novel methods to control the disease. The purpose of this study was to evaluate the contribution of SNP in candidate genes to host genetic components of response to PRRSv infection. At ~3 weeks of age, ~800 pigs were infected with PRRSv. Weight gain (WG) was evaluated up to 42 d post-infection (dpi). Areas under the curve of log-transformed viral qRT-PCR levels in serum collected up to 21 dpi quantified viral load (VL). Pigs were genotyped using the Illumina Porcine SNP60 Beadchip. At Washington State University, 616 pigs were genotyped for 31 mutations (cgSNP) discovered in 14 candidate genes based on transcriptome analysis. ASREML was used to estimate the effect of each cgSNP. Five cgSNP in 3 genes were found to significantly ($P < 0.05$) affect both VL and WG, including 2 cgSNP in a region on Sus Scrofa chromosome (SSC) 4 that was associated with WG and VL in previous analyses of this data with SNP60 genotypes. To evaluate if the cgSNP captured novel effects, cgSNP were added to SNP60 genotypes and analyzed using Bayes-B (Pi = 0.99) in GenSel. Addition of the cgSNP did not affect the regions that were identified using the SNP60 genotypes. The 2 cgSNP on SSC4 contributed minimally to the genetic variation for WG explained by the SNP60 panel, which could be due to high LD. The SSC4 cgSNP effects were similar in direction to the SNP60 effects in this region, as animals with the desirable allele had lower VL and higher WG. Analysis of these cgSNP on additional trials and phenotypes may provide insight into their role in piglet response to PRRSv infection. This work was supported by the National Pork Board, PRRS CAP, USDA ARS and NIFA Award 2008–55620–19132, the NRSP-8 swine and bioinformatics coordination projects, and the breeding companies that provided pigs. EW is a Fellow supported by USDA NIFA National Needs grant 2010–38420–20328.

Key Words: PRRS, swine, markers, candidate gene

66 Genetic correlations between carcass traits and genomic breeding values in Limousin cattle. M. Saatchi*[1], D. Garrick[1], and J. Taylor[2], *[1]Iowa State University, Ames, [2]University of Missouri, Kansas City.*

In a national evaluation, genomic breeding values (GEBV) can be considered as a correlated trait to that for which phenotypes are available for the traditional estimation of breeding values. To accomplish this, estimates of the genetic correlations between traits and respective GEBV are required. We derived GEBV in 2,239 registered Limousin cattle genotyped with the BovineSNP50 assay and from which we estimated these correlations. Deregressed estimated breeding values (DEBV) were used as observations in a weighted analysis that estimated marker effects to derive GEBV. Genotyped individuals were clustered into 5 groups using k-means clustering with the aim of increasing the within-group and decreasing the between-group pedigree relationships. Cross-validation was performed 5 times using 4 groups for training and the fifth group for validation. For each trait, we applied a weighted bivariate analysis using the GEBV of genotyped animals from all 5 validation sets and their corresponding DEBV to estimate variance and covariance components. Estimated heritabilities of GEBV exceeded 0.80. Estimated genetic correlations between each trait and GEBV were 0.79, 0.73, 0.68 and 0.67 for marbling, carcass weight, rib eye area and yield grade, respectively. Heritabilities of GEBV less than one reflect differences in the prediction equations between the 5 validation groups as well as genotyping errors, missing pedigree information and effects of selection. Estimates of genetic correlations reflect the pooled accuracies of GEBV. The GEBV show promise for routine use by Limousin breeders to predict genetic merit of animals at a young age.

Key Words: genomic breeding values, genetic correlations, beef cattle, Limousin

67 Understanding the effects of group housing on the development of dairy calves. A. D. P. Vieira*, *University of British Columbia, Vancouver, BC, Canada.*

Despite the recent move toward group housing, in most dairy farms calves are still housed individually. Individual housing was originally recommended as a way of preventing disease transmission between calves. However, in well-managed commercial systems (e.g., where calves are fed a good quality colostrum soon after birth and provided higher milk volumes via an artificial teat and where calves are housed in small groups and efficient biosecurity measures are adopted), there is no clear advantage of housing calves individually versus in small groups. In fact, preventing calves from engaging in social interactions can negatively influence calf development. For example, individually housed calves vocalize more at weaning and gain less weight when grouped because they take longer to feed when compared with calves housed in pairs. This maladjustment to grouping happens because dairy calves require specific cues (e.g., social cues provided by other calves) that allow them to better locate feed resources in a novel environment. Social learning can also benefit dairy calves during the transition from a milk-based diet to one of solid feed. For example, when compared with calves housed in groups of similar age, calves housed with an older weaned companion visit the starter and hay feeders more often before weaning, show increased hay intake before weaning, consume more starter after weaning and gain more weight overall. Group size is also important because housing calves in larger groups increases the risk of illness compared with housing in smaller groups. Therefore, in well-managed commercial systems it is recommended that calves be housed in smaller groups and that competition for resources be reduced by increasing the number of feeding stations as well as the volume of milk provided throughout the day. Also, when introducing dairy calves to novel feeding systems, it is necessary that calves be provided clearer cues that can help them learn where, how, when and what to feed.

Key Words: group housing, social development, calf growth

68 Use of technology to improve the accuracy and precision of feeding dairy cattle. N. B. Litherland*, *University of Minnesota, St. Paul.*

New and affordable technology is available that allows dairy producers to improve the accuracy and precision of feeding. Precision dairy nutrition is a systems concept that allows producers to account for daily variation that occurs on farms. The 5 main components of a precision dairy nutrition system include; 1) harvest; 2) modeling cow requirements; 3) feeding management; 4) milk nutrient output; 5) waste nutrient output. Precision dairy nutrition potentially can affect farm productivity, efficiency and profitability. We recently tested new precision feeding technology. The objectives of the study were to determine the effects of real-time adjustment of ingredient dry matter (DM) using near-infrared reflectance (NIR) IRM (Intelligent Ration Monitoring) on ingredient DM, DM intake (DMI), and milk yield (MY). We hypothesized that real-time adjustment of DM would reduce TMR variability compared with weekly DM adjustment. Five hundred dairy cows in 2 pens on a commercial dairy were used in a crossover design with 9 wk periods. Pens were balanced by MY (52.4 Kg/cow/d) and days in milk (111.2 d). Two treatments: (Control) weekly correction of ingredient DM of corn silage, alfalfa silage and high moisture corn by drying for 12 h 100°C oven; (IRM) the IRM scanned individual ingredients and adjusted DM during diet mixing. Diets varied only by method of DM adjustment. Data were analyzed using Proc Mixed in SAS with repeated measures and PDIFF for mean separation. Control and IRM TMR DM averaged 45.9 and 46.0 ± 1.3%; $P = 0.93$). TMR starch, CP, ADF and NDF were similar. DMI averaged 26.5 and 26.9 ± 1.3 Kg/d; $P = 0.7$. DM refused averaged 5.0 and 4.7 ± 1.5%/cow/d; $P = 0.6$. MY and 3.5% FCM yield averaged 52.9 and 52.8 ± 1.3 kg/d; $P = 0.9$ and 56.5 and 54.6 ± 2.3 kg/d; $P = 0.1$ for control and IRM. Milk protein was higher (2.9 vs. 3.0% ± 0.2) (Trt × week; $P < 0.05$) for IRM. Milk fat % and yield averaged 3.8 and 3.7 ± 0.2%; $P = 0.7$) and 2.0 and 1.9 ± 0.1 kg/d; $P = 0.3$ for control and IRM. Dairy efficiency was 2.2 and 2.0 ± 0.1; $P = 0.1$ for control and IRM. IRM cows performed as well as those fed using traditional DM adjustment.

Key Words: precision feeding, dairy nutrition, NIR, TMR dry matter

69 Precision dairy technology: Use of cow-side technologies for improving management. M. M. Schutz*[1], J. M. Bewley[2], and J. R. Townsend[1], *[1]Purdue University, West Lafayette, IN, [2]University of Kentucky, Lexington.*

Precision dairy farming (PDF), by definition, is the use of technologies to routinely measure physiological, behavioral, and production indicators of individual animals to inform management decision-making relative to health and performance. Some data have long been captured for use in dairy farm decision-making such as milk weights, body weights, milk components, and indicators of estrus. However, recent development of PDF technologies has been marked by ability of computer systems to capture and interpret copious amounts of data transmitted frequently from sensors. Examples of available or emerging PDF technologies include, in-line measures of fat, protein, lactose, somatic cells, and blood in milk; electrical conductivity of milk, cow activity and pedometry; lying behavior; daily body weight and limb weight distribution; jaw movement; rumen pH; reticular contractions; heart rate; animal location; jaw and chewing motion; heart rate; electrical resistance of vaginal mucus; methane emission; throat acoustics; blood glucose; milk progesterone; respiration rate; milk, ruminal, cochlear, and vaginal temperature; and infrared udder surface temperature. The goals of PDF are to enhance a manager′s ability to maximize animal productivity, optimize timing and effectiveness of intervention in disease events, and reduce treatment costs and use of medicine through proactive health management. Unfamiliarity with available technologies and fear of costs outweighing benefits are the most important reasons dairy producers do not invest in these technologies. Data overload and inability to interpret data are also impediments to adoption. Further research will position data from combinations of PDF technologies to better predict manageable events and enhance their utility. Ultimately, some PDF technologies are likely to evolve into true biofeedback loops in which intervention is automatically triggered when PDF sensors detect biological measures exceeding threshold limits for individual animals or groups.

Key Words: precision dairy farming, dairy cattle, management

70 Investigation of *Lawsonia intracellularis* serodynamics according to age and annual season using a standardized diagnostic methodology in growing swine. G. Anderson, E. Johnson, and J. Husa*, *Boehringer Ingelheim Vetmedica Inc., St. Joseph, MO.*

The objective of this study was to evaluate cross-sectional *Lawsonia intracellularis* (Li) serological results from US swine herds to determine if seasonal differences exist in Li seroprevalence. Swine herds (n = 116) were cross-sectionally sampled over a 4 year period (2007–2010). Reasons for the diagnostic investigations included clinical signs of disease or history of poor performance in a flow. Clinical signs may or may not have been indicative of Li infection. Serum samples were assayed for Li antibodies using a blocking ELISA. In order for a flow to be included in the analysis, it had to have Li ELISA results from at least 10 pigs in a minimum of 4 out of 5 wean–to–market age groups, which were sampled in a single season. The wean–to–market age groups were: Early Nursery (3–7 wks), Late Nursery (8–12 wks), Early Finishing (13–17 wks), Mid-finishing (18–22 wks), and Late Finishing (23–27 wks). Seasons were separated into 4 categories: winter, spring, summer, and fall. Of the 116 pig flows available, only 85 met the inclusion criteria for this analysis (12 winter, 16 spring, 32 summer, and 25 fall). All of the flows tested had at least one Li positive ELISA result. Prevalence of Li in the early nursery, late nursery, early finishing, mid-finishing, and late finishing phases averaged 1%, 3%, 24%, 57%, and 74% for each phase, respectively. No differences ($P > 0.05$) were detected in seasonal Li prevalence in the early nursery, late nursery, and early finishing phases. In mid-finishing, Li prevalence was greater ($P < 0.05$) in the spring compared with the winter (46.3% vs. 67.3%). In late finishing, Li prevalence was greater ($P < 0.05$) in the fall compared with the spring (81.3% vs. 65.5%). There were no significant ($P > 0.05$) differences between Li prevalence in the cool seasons (winter and spring) compared with the warm seasons (summer and fall) in any of the age groups. This data indicates there is no difference in the serological prevalence of Li in warmer vs. cooler seasons, and that ileitis is a year–round concern.

Key Words: *Lawsonia*, ileitis, swine

71 Effect of supplemental zinc source and ractopamine on grow-finish pig growth performance and carcass characteristics. Z. Rambo*[1], A. Schinckel[1], M. Wilson[2], T. Ward[2], and B. Richert[1], *[1]Purdue University, West Lafayette, IN, [2]Zinpro Corporation, Eden Prairie, MN.*

Two hundred crossbred pigs were blocked by BW (d 0 = 81.1 ± 0.22 kg) and allocated in a randomized complete block design of mixed gender pens, to 5 treatments with 8 pens/treatment. Dietary treatments contained either 50 ppm supplemental available zinc from ZnO or Zn–amino acid complex (Availa zinc, AZ) d 0–56 and ractopamine (RAC; 7.5 ppm) during d35–56 of the study. From d 35–56, animals were fed their respective finishing dietary treatments: 1) control (0.70% TID Lys)+ZnO; 2) high lysine (1.00% TID Lys)+ZnO; 3) high lysine+AZ; 4) Diet 2+RAC; or 5) Diet 3+RAC. Diets were formulated to meet or exceed NRC (1998) nutrient requirements with the basal diet containing 48 ppm supplemental Zn from ZnO. One barrow and one gilt closest to the pen mean BW were harvested at Purdue University to evaluate carcass measurements, measures of pork quality and ham composition. Supplemental zinc source had no effect on ADG, ADFI, or G:F during d 0–35 ($P > 0.40$). From d 35–56 and overall (d 0–56), for pigs fed RAC (diets 4 and 5) had greater ADG ($P < 0.001$) and G:F ($P < 0.001$) and lower ADFI ($P < 0.001$) than pigs fed diets 2 and 3. From d 35–56, pigs fed AZ had 6.13% greater ADG ($P = 0.05$) and tended to have greater G:F ($P < 0.10$) than pigs fed ZnO. Also, pigs fed diet 1 had greater ADG ($P < 0.01$) and ADFI ($P < 0.03$) than pigs fed diet 2 from d 35–56. Pigs fed diet 5 tended to have greater G:F than pigs fed diet 4 ($P < 0.10$), which was intermediate to pigs fed diets 1, 2, and 3, (0.263, 0.249, 0.255, 0.330 and 0.307, Diet 1–Diet 5, respectively). Overall, pigs fed AZ tended to have 2.9% greater ADG ($P = 0.06$) than pigs fed ZnO. Zinc–amino acid complex and RAC increased ($P < 0.05$) HCW by 2.9% and 4.6%, respectively. Ractopamine increased ($P < 0.05$) primal ham weight 5.2% and dissected ham lean weight by 8.4%. Feeding finishing pigs an iso–level of AZ compared with ZnO improved pig ADG and G:F, with a greater improvement in growth and carcass parameters observed when AZ is fed in combination with RAC.

Key Words: ractopamine, amino acid complex, zinc, zinc oxide

72 Cull sow knife-separable lean content evaluation at harvest and lean mass content prediction equation development. C. Abell*[1], K. Stalder[1], H. Hendricks[2], S. Lonergan[1], and R. Fitzgerald[3], *[1]Iowa State University, Ames, [2]Utah Pork Producers Association, Providence, [3]PIC, Hendersonville, TN.*

The objective of this study was to determine knife-separable lean expected from individual primal cuts and the entire cull sow carcasses. A second goal was to develop a prediction equation for carcass knife-separable lean within and across USDA cull sow market weight classes. The USDA cull sow weight classes are based on the following live weight classes: class 1 (136.1 to 204.1 kg), class 2 (204.2 to 226.8 kg), class 3 (226.9 to 249.5 kg), and class 4 (249.6 kg and greater). A total of 176 cull sows carcasses produced by area commercial pork operations near Ogden, Utah were evaluated in this study. Knife separable lean, fat, skin, and bone were evaluated by primal. There were significant percent lean and fat differences among the same primal cuts across USDA cull sow weight classes. The 2 lightest USDA cull sow market weight classes had a greater carcass percent lean and lower percent fat compared with the 2 heaviest weight classes. To develop a lean content prediction equation, a stepwise regression analysis and the maximum R option was utilized (SAS Institute Inc., Cary, NC). Hot carcass weight, backfat, and loin muscle area were considered as fixed effects in the models used to develop lean prediction equations. In general, hot carcass weight explained most of the variation in carcass lean (46–88%). Additionally, backfat was a significant variation source when predicting carcass lean (14–48%). The equation developed across the USDA cull sow weight classes had a 0.90 R^2 value, which was greater than the R^2 values from the equations developed for each individual weight class. The findings support using a single equation when predicting lean content across all USDA cull sow market weight classes. This prediction equation could assist processors when making cull sow purchasing decisions to determine the animals from various USDA weight classes that will meet the processor's needs for pork products with defined lean:fat content, such as brats and sausage. Predicting lean content could more precisely determine the value of the carcass benefiting producers and processors.

Key Words: cull sow, carcass composition, lean, prediction equation

73 The effect of temperature and duration of storage of frozen-thawed boar sperm on measures of post-thaw fertility. J. M. Ringwelski* and R. V. Knox, *University of Illinois, Urbana.*

Frozen-thawed boar sperm (FTS) is known to have reduced fertility, due in part to a shorter in vitro and in vivo fertile lifespan when compared with liquid extended semen. It is not clear whether alternative storage temperatures following thawing can help to extend the lifespan of FTS. The objective of this experiment was to evaluate in vitro measures of fertility when storing FTS at 17, 26, or 37°C. Ejaculates (n = 20) from 17 boars were frozen in 0.5-mL straws. All samples were assigned to a 3 × 4 factorial treatment design with samples stored at 17, 26, and 37°C for 2, 6, 12, and 24 h. One straw from each ejaculate was thawed at 50°C for 20 s and diluted into 10 mL of Androhep Thaw Extender at 26°C, to a final concentration of 7×10^8sperm/mL. A sub-sample was evaluated at 0 h (30 min) to establish pre-treatment fertility measures. The extended sample was then divided into 3-mL aliquots and placed at 17, 26, or 37°C. Each tube was sub-sampled during storage. Motility (MOT) was evaluated in 10 fields at 200× and viability (VIA) determined using propidium iodide. Analysis occurred by MIXED procedures for a factorial design for the effects of temperature, duration of storage, and boar. At 0 h, MOT averaged 48.7 ± 0.8% and VIA 52.7 ± 1.3%. There was an interaction of temperature and duration of storage for MOT and VIA ($P < 0.001$). Motility and VIA remained constant during the 2-h storage period (>40%). At 6 h, samples stored at 37°C, showed a 35% decline in fertility, while samples stored at 17 and 26°C declined only 10%. Storage for 12 h resulted in additional loss of 20% for 37°C samples, and only 5% loss for 17 or 26°C samples. By 24 h, all samples held at 37°C were non-motile with <5% viability, while samples stored at 17 and 26°C averaged 20%. Interestingly, boar influenced response to treatment ($P < 0.001$). These results indicate that FTS can be extended and held at 17 or 26°C for up to 12 h before use; allowing for preparation and storage of multiple doses at one time. While storage of FTS at 37°C is detrimental to in vitro fertility, it could be indicative of in vivo sperm survival.

Key Words: boar, frozen, sperm

74 Effect of thawing temperature and duration of thawing on in vitro fertility measures of boar sperm cryopreserved in 0.5-mL straws. K. A. McNamara* and R. V. Knox, *University of Illinois, Urbana.*

The effect of thawing rate has been shown to influence post-thaw quality of frozen-thawed boar sperm (FTS). The objective of this experiment was to evaluate the effect of thaw temperature and duration of thawing on fertility measures. Ejaculates (n = 15) used in this study were from 13 boars collected and frozen from March 2010 to March 2011. Ejaculates were frozen in 0.5-mL straws using Androhep Cryoguard Freezing Extender at a concentration of 1.4×10^9 cells/mL. To test for the effects of thawing temperature and duration, individual straws from each ejaculate were assigned to all treatments. The treatments included straws (n = 15/treatment) thawed at 50°C for 10 s, 20 s, and 30 s or thawed at 70°C for 5 s, 10 s, and 20 s. Following thawing, the FTS was expelled into a glass tube in a 37°C heating block. The sample was diluted 1:40 in Androhep Cryoguard Thaw Extender at 37°C and then evaluated for post-thaw motility (PTM). For membrane integrity (MI) and intact acrosome (IA), FTS were diluted 1:50 in Beltsville Thawing Solution. Samples were evaluated at 5, 30, and 60 min for PTM at 200× in 10 fields, and for MI using propidium iodide and for IA using FITC-PNA staining. Data were analyzed using MIXED procedures for the effects of temperature, thaw duration, and boar. There was an effect of temperature and duration of thawing ($P < 0.0001$) on PTM, MI, and IA. There was no difference in PTM (~41%) across all treatments except when thawing at 70°C for 20 s (3%). Thawing at 70°C for 5 s resulted in lower MI (50%) compared with other treatments (~56%), however, thawing at 70°C for 20 s resulted in the lowest MI (6%). All treatments had ~80% IA, except when thawing at 70°C for 20 s (62%). The results indicate that when thawing boar sperm in 0.5 mL straws with the cryoprotectant used, 70°C for 20 s rendered most sperm infertile, while thawing at 70°C for 10 s and 50°C for 20 s resulted in the highest PTM, MI, and IA.

Key Words: boar, frozen, sperm

75 The effect of insemination interval following AI with frozen-thawed boar sperm on pregnancy rate, litter size, and fetal paternity in mature gilts. J. M. Ringwelski*, K. A. McNamara, M. S. Bojko, J. E. Beever, and R. V. Knox, *University of Illinois, Urbana.*

The use of frozen-thawed boar sperm (FTS) for AI in swine is limited due to lower fertility rates. However, improved AI timing can increase pregnancy rate and litter size. This experiment was designed to test the effect of AI interval on fertility in mature gilts when using FTS. The semen freezing and breeding trials occurred during Aug. 2010 to Aug. 2011. Semen from 11 boars was collected and frozen in 0.5 mL straws at 1.4×10^9sperm/mL. Gilts (n = 191) were mated in 6 replicates following synchronization using Matrix. Gilts were checked twice daily and randomly assigned at onset of estrus to one of the following treatments: 1) AI at 4 h interval (34 and 38 h); 2) AI at 8-h interval (30 and 38 h), or 3) AI at 16-h interval (22 and 38 h). Within each treatment, the 1st and 2nd AI were from unique sires to allow identification of fetal paternity using an array of microsatellite markers. Gilts received 2×10^9 motile sperm in 80 mL of extender by intra-cervical AI. Each sire was represented across treatments and 1st and 2nd AI. Time of ovulation was determined using ultrasound at 12 h intervals. Pregnancy rate and litter size were assessed at d 35 of gestation following sacrifice and fetal tissue samples were collected for paternity testing. Data were analyzed using GENMOD and MIXED procedures of SAS for the main effects of treatment, replicate and estrus to ovulation interval. Post-thaw sperm were 52.1 ± 1.2% motile, 56.6 ± 1.9% viable and 99.7 ± 0.0% acrosome intact.Treatment affected pregnancy rate ($P < 0.01$), with gilts receiving AI at 8 (75.5%) and 16 (67.4%) h intervals greater than those receiving inseminations at 4 h intervals (51.5%). Litter size was not affected by treatment ($P > 0.10$) and averaged 10.2 ± 0.4 fetuses. Estrus to ovulation interval also influenced pregnancy rate ($P < 0.05$) but did not influence LS ($P > 0.10$). When using FTS with double AI, highest fertility occurs when AI occur at 8 to 16 h intervals with estrus detection at 12 h intervals. However, estrus detection occurring once daily or at irregularly spaced AM/PM intervals may not allow AI to occur at desired intervals.

Key Words: AI, boar, frozen, sperm

76 Evaluation of lactation feed intake in purebred and crossbred sows. C. L. Yoder*[1], J. S. Fix[2], C. R. Schwab[2], and T. J. Baas[1], *[1]Iowa State University, Ames, [2]National Swine Registry, West Lafayette, IN.*

Daily feed intake during lactation was recorded on purebred Yorkshire (n = 1,587) and Landrace (n = 2,197), and F_1 Yorkshire × Landrace (n = 6,932) females from d 1 to 22 of lactation. Average lactation length was 18.52 ± 2.01 d and average parity was 3.52 ± 2.07. Lactation feed intake (LFI) curves were predicted using a mixed model which included fixed effects of breed, season, parity, day of lacta-

tion, and interactions of day with breed and parity; and a covariate for number of pigs after transfer. Random effects included sire nested within breed, dam, litter, and contemporary group (month-year-herd). The LFI curves were predicted through d 22 of lactation using least squares means of the breed by day interaction. Yorkshire and Landrace LFI curves were not different ($P = 0.09$), though both differed from the crossbred LFI curve ($P < 0.05$). Evaluation of the slope of individual LFI curves between 2 consecutive days resulted in the following classifications ($P < 0.05$): 3 periods for purebred lines, d 1 to 6 (P1), d 7 to 10 (P2), d 11 to 18 (P3), 2 periods for crossbred sows, d 1 to 5 (C1) and d 6 to 18 (C2). Due to a limited number of observations, d 19 to 22 were not included when calculating slopes. Genetic parameters were estimated using Gibbs sampling (Gibbs2f90, University of Georgia) with an animal model which included fixed effects of breed, season, and parity, and a random effect of contemporary group. Heritability estimates from purebred data were: P1 (0.06), P2 (0.03), P3 (0.01); and from crossbred data: C1 (0.14) and C2 (0.20). The genetic correlation between lactation periods P2 and P3 was 0.65 ($P < 0.05$), and all other correlations not significantly different from zero. The slope and the shape of LFI curve varied between purebred and crossbred sows. Based on these results there is potential to alter lactation feed intake through genetic selection.

Key Words: genetics, lactation, feed intake, sows

77 Quantifying deviations from predicted lactation feed intake in sows. C. L. Yoder*[1], J. S. Fix[2], C. R. Schwab[2], P. M. Dixon[1], and T. J. Baas[1], *[1]Iowa State University, Ames, [2]National Swine Registry, West Lafayette, IN.*

The objective of this study was to quantify negative deviations from predicted daily lactation feed intake (DEV) and frequency of occurrence during lactation. The frequency of negative DEV was evaluated using daily feed intake records from d 1 to 22 of lactation on purebred Yorkshire (n = 1,587) and Landrace (n = 2,197) females, and F1 Yorkshire × Landrace (n = 6,932) females. Average lactation length was 18.52 ± 2.01 d and average parity was 3.52 ± 2.07. Daily lactation feed intake (LFI) values were predicted using a mixed model which included; fixed effects of breed, season, parity, day of lactation, and interactions of day by breed and day by parity; and a covariate for number of pigs after transfer. Random effects included sire nested within breed, dam, litter, and contemporary group (month-year-herd). Deviations from predicted LFI were quantified using an internally studentized residual (SR). A SR less than −1.71, 5 percent of daily LFI records, was considered a negative DEV. There were no negative DEV in 60% of litters, 1 occurrence in 18%, and 22% had >1 occurrence during lactation. In purebred litters 17.0% of negative DEV occurred in d 1 to 6, 17.5% in d 7 to 10, 53.0% during d 11 to 18, and 12.5% after d 18. In crossbred litters 8.0% of negative DEV occurred in d 1 to 5, 85.0% occurred in d 6 to 18, and 7.0% occurred after d 18. During the summer (June, July, Aug.) 34% of negative DEV occurred, while 17% occurred during the winter (Dec., Jan., Feb.), 26% during spring (March, April, May), and 23% during fall (Sept., Oct., Nov.). Litter weaning weight, adjusted for breed, parity, lactation length, and number after transfer, decreased with increasing number of negative DEV. When 3 or more negative DEV occurred in one lactation period wean to first service interval increased ($P < 0.05$). A negative deviation from predicted LFI is more likely to occur later in lactation and the summer, and negatively effects reproductive performance.

Key Words: feed intake, lactation, studentized residual

78 The effects of diet form and feeder design on growth the performance of finishing pigs. A. J. Myers*, R. D. Goodband, M. D. Tokach, S. S. Dritz, J. M. DeRouchey, and J. L. Nelssen, *Kansas State University, Manhattan.*

Two studies were conducted to determine the effects of diet form (meal vs. pellet) and feeder design (dry vs. wet-dry) on finisher pig performance. Experiments were arranged as 2 × 2 factorials with 11 replications/treatment. In Exp. 1, 1,290 pigs (initial BW 46.8 kg) were used in a 91-d trial. Pelleted diets averaged 35% fines throughout the study. Overall, pigs fed pelleted diets (0.86 kg/d) or via wet-dry feeders (0.86 kg/d) had greater ($P < 0.07$ and 0.01, respectively) ADG than those fed meal diets (0.83 kg/d) or with dry feeders (0.83 kg/d). A diet form × feeder interaction ($P < 0.01$) was observed for G:F. Pigs fed meal or pelleted diets via a wet-dry feeder had similar G:F (0.319 and 0.320, respectively), but pigs fed pelleted diets in dry feeders had poorer G:F than pigs with meal diets in dry feeders (0.349 and 0.369, respectively). In Exp. 2, 1,146 pigs (initial BW 38.2 kg) were used in a 104-d study. From d 0 to 28, a diet form × feeder interaction ($P < 0.01$) was observed for ADG. Pigs fed pelleted diets from a dry feeder (0.58 kg/d) had decreased ADG compared with pigs fed meal diets from the same feeder type (0.66 kg/d) while there was no difference in wet-dry feeders based on diet form (0.63 and 0.67 kg/d, respectively). Pigs fed pelleted diets (0.392) had poorer ($P < 0.01$) G:F compared with those fed meal diets (0.443). This appeared to be due to poor pellet quality (39.6% fines). From d 42 to 86, pellet quality improved (4.4% fines) and a diet form × feeder interaction ($P < 0.05$) was observed for ADG. Pigs fed meal diets in a dry feeder (0.96 kg/d) had lower ADG compared with pigs fed pelleted diets in dry feeders (1.03 kg/d) or pigs fed either diet in wet-dry feeders (1.05 and 1.06 kg/d, respectively). Overall, pigs fed with wet-dry feeders had increased ($P < 0.02$) ADG and ADFI, and poorer G:F compared with those with dry feeders, while pigs presented pelleted diets had better ($P = 0.05$) G:F compared with those presented meal diets. Pigs provided high quality pellets via dry feeders had increased growth performance compared with pigs fed meal diets. Conversely, if pellet quality was poor, G:F benefits associated with pelleting were lost.

Key Words: feeder, finishing pig, growth, pelleting

79 Impact of a ractopamine feeding strategy on growth, efficiency and carcass traits in finishing pigs. G. D. Gerlemann*[1], S. N. Carr[2], M. J. Ritter[2], and G. L. Allee[1], *[1]Porktech LLC, Columbia, MO, [2]Elanco Animal Health, Greenfield, IN.*

The objective was to determine the effects of feeding ractopamine hydrochloride (RAC; Paylean, ELANCO Animal Health, Greenfield, IN) on growth performance and carcass traits of finishing pigs with 2 separate harvest dates. Pigs with an average weight of 104 kg were allotted to 3 treatments in a RCBD with start date as the blocking factor. Treatments consisted of 2 RAC treatments: RAC step-up (5 ppm for 17 d followed by 10 ppm for 14 d), constant RAC (7.4 ppm for 31d), and a control. Isocaloric corn-soy diets (control 0.65 TID lys; RAC 0.94 TID lys) that met nutrient requirements were fed. Pen weights and feed disappearance were recorded on d 0, 17 and 31. Pigs were marketed to a commercial harvest facility d17 and 31. The heaviest 20% of the pigs within each pen were marketed on d17, standardizing pens to 17 or 18 pigs per pen. The remaining pigs in each pen were then marketed on d31. Hot carcass weight (HCW), loin depth (LD), backfat depth (BF), and percent lean (PL) were then collected at the plant. Data were analyzed by using PROC Mixed of SAS. No differences ($P > 0.05$) were observed between the RAC step-up and constant treatments so data were pooled and compared with the control. During period 1 (d 0–17) RAC improved ($P < 0.01$) ADG (1.19 vs. 1.03 kg) and G:F (0.38 vs. 0.33). In period 2, (d 17–31) RAC improved ($P < 0.01$) ADG (1.21 vs. 1.12 kg) and G:F (0.34 vs. 0.31). Overall results show RAC improved ($P < 0.0001$) ADG (1.20 vs. 1.07 kg) and G:F (0.36 vs. 0.32). In the pigs marketed at d 17, RAC increased ($P < 0.03$) LD (61.84 vs. 59.91 mm), HCW (101.23 vs. 99.36 kg), and yield (74.60 vs. 74.15%). In pigs marketed at d31, RAC decreased ($P < 0.05$) BF (21.10 vs. 22.14 mm), while increasing ($P < 0.01$) LD (62.70 vs. 59.41 mm), PL (52.11 vs. 51.39), HCW (103.10 vs. 99.12 kg), and yield (74.76 vs. 74.09%). Overall, RAC increased ($P < 0.01$) LD (62.48 vs. 59.53 mm), PL (52.02 vs. 51.38), HCW (102.69 vs. 99.16 kg), and yield (74.72 vs. 74.09%). Feeding RAC at a constant dose or in a step-up program improved growth performance and carcass traits compared with the control, evident up to 31 d.

Key Words: swine, ractopamine

80 Impact of tylosin phosphate and ractopamine hydrochloride alone or in combination on N metabolism in finishing pigs. C. M. Pilcher*[1], R. Arentson[2], and J. F. Patience[1], *[1]Iowa State University, Ames, [2]Elanco Animal Health, Greenfield, IN.*

Ractopamine hydrochloride (RAC) is a nutrient repartitioning agent added to diets in late finishing to increase weight gain, feed efficiency and carcass leanness. Tylosin phosphate (TP) is a macrolide antibiotic used in swine diets to control diseases such as ileitis and swine dysentery and to improve growth performance. There is very limited information on the effect of these 2 products when used in combination. The objective of this study was to evaluate the effect of TP and RAC alone or in combination on whole-body N metabolism in finishing pigs fed corn-soybean meal or corn-soybean meal-dried distillers grains with solubles (DDGS) based diets. A total of 72 PIC gilts (initial BW = 107.4 ± 0.50 kg) were blocked by weight and randomly assigned to a 2 × 2 × 2 factorial arrangement of treatments: TP (0 or 44 ppm), RAC (0 or 5 ppm) and DDGS (0 or 30%). When RAC was included, diets were formulated to contain an additional 0.2% SID Lys. Pigs were housed individually and fed treatment diets for 17 d. TP treated pigs were administered 66 mg tylosin per liter of water for 3 d before receiving treatment diets. Feed was provided twice daily, as much as the pigs could consume within 1 h per meal (ADFI = 2.98 ± 0.045 kg/d). Water was provided to the pigs between feeding periods, ad libitum (ADWI = 7.76 ± 0.23 kg/d). Feces and urine were collected during 2 sampling periods on d 7 and 8 and d 15 and 16. DDGS inclusion reduced apparent total tract digestibility (ATTD) of N (81.2 vs. 83.3; $P < 0.0001$) and N retention (45.5 vs. 49.7% of N intake; $P < 0.01$); however, there were no interactions between the response to DDGS and the responses to TP or RAC. RAC increased ATTD of N (83.7 vs. 80.8%; $P < 0.0001$) and N retention (38.6 vs. 30.0 g/d; $P < 0.0001$ and 50.1 vs. 45.2% of N intake; $P < 0.001$). For N retention (g/d), there was an increase in the response to RAC when TP was present in the diet (TP × RAC interaction; $P < 0.05$). TP also tended to improve ATTD of N (82.6 vs. 81.9%; $P = 0.054$), but did not affect total N excretion. In conclusion, RAC increased N retention, TP may enhance the response to RAC, and the inclusion of DDGS did not affect the responses to either TP or RAC.

Key Words: ractopamine, tylosin phosphate, swine

81 Method for validating diet ME versus NE using growth assay and modeling in growing pigs. A. P. Schinckel*[1], M. E. Einstein[1], S. Jungst[2], and R. D. Boyd[3], *[1]Purdue University, West Lafayette, IN, [2]PIC North America, Hendersonville, TN, [3]The Hanor Company, Franklin, KY.*

A method to validate diet energy value (ME, NE) using growth assay and modeling technique is described. We measured BW growth, energy intake, composition data and used reverse modeling, to compare ME and NE estimates for accuracy in predicting G:F. The accuracy of an NE estimate for wheat middlings (by growth phase, gender) was evaluated. Amount of BW gain per unit NE or ME intake above maintenance is a function of protein:lipid deposition. Data from a growth assay, involving 2178 castrates and 2274 gilts, were used to illustrate this method. Pen feed intake data were obtained from 27 kg BW to target BWs of 118, 127, 131.5 and 140.6 kg. Pigs from 4 sire lines were allocated to a series of low energy (LE) corn-soybean meal based diets with 16% wheat middlings or high energy diets (HE) having 4.5 to 4.95% choice white grease. All diets contained 6% DDGS. LE diets contained 3.27 Mcal ME and 2.36 to 2.42 NE/kg; HE diets had 3.54 Mcal ME and 2.62 to 2.68 NE/kg. Pigs were weighed and pen feed intake recorded at 28-d intervals. Daily energy intake curves were developed by fitting the castrate and gilt daily ME (MEI) and NE (NEI) intake data to Bridges functions of BW. The BW data of each sex were fitted to a generalized Michaelis-Menten function of days of age. ME and NE required for maintenance (Mcal/d) were predicted using functions of BW (0.255 and 0.179 $BW^{0.60}$, respectively, Noblet et al. 1999). No differences were observed in MEI for pigs fed HE and LE diets (8.52 vs 8.54 Mcal/d, $P = 0.49$). Pigs fed LE diets had decreased NEI (6.33 vs 6.44 Mcal/d, $P = 0.01$). Pigs fed the HE diets had 3.6% greater ADG:MEI and only 1.3% greater ADG:NEI, therefore NEI is a more accurate predictor of growth and G:F than MEI. Pigs fed HE diets had 3.4% greater ADG:Mcal MEI and 0.11% greater ADG:NEI above maintenance than LE diets . Based on backfat difference (19.4 versus 18.4 mm, $P < 0.05$), pigs fed the LE diets should have had 3.2% greater ADG:NEI above maintenance ($P < 0.01$) than pigs fed the HE diets. The data suggest that the middlings NE value (2.132 Mcal/kg) was too high for this source or that maintenance was increased for pigs fed LE diets.

Key Words: net energy, pigs, growth rate, feed efficiency

82 Composition of porcine colostrum and milk as affected by various production environments. G. Voilqué*, Y. Zhao, and S. W. Kim, *North Carolina State University, Raleigh.*

Colostrum and milk composition can be influenced by production environments to sows. Nutritional effects are well investigated whereas other production environments are not. This study examined the effects of ambient temperature (AT) and gestation housing (GH) on composition of porcine colostrum and milk. Eighty-one sows were randomly assigned to 4 treatments based on a 2 × 2 factorial arrangement with AT (21.5°C or 27.3°C) and GH (individual crate or small pen) as main factors. All sows received the same diet meeting the requirements. Colostrum (within 24 h after farrowing) and milk (on d 18 of lactation) were obtained from all sows to measure composition of fat, protein, and lactose. Sows in high AT tended to produce colostrum with a lower ($P = 0.08$) protein content (52.9% of DM) than sows in moderate AT (46.5% of DM). However the composition of fat and lactose in colostrum was not affected ($P > 0.10$) by AT. Also AT did not affect ($P > 0.10$) the composition of fat, protein, and lactose in milk. The GH did not affect ($P > 0.10$) the composition of fat, protein, and lactose in colostrum. However sows from individual crates have smaller ($P = 0.02$) protein content (31.6% of DM) in milk compared with sows from small pen (35.6% of DM). An increase of parity from 2 to 6 linearly increased (fat%DM = 3.03 × parity + 17.14, $P = 0.03$ for the slope, $P = 0.01$ for the intercept, $R^2 = 0.09$) fat content in colostrum, whereas other components in colostrum and milk were not affected ($P > 0.10$). Sows body weight at d 109 of gestation, and at d 1 and 18 of lactation did not affect ($P > 0.10$) the composition of colostrum and milk. Lactose content linearly increased ($P = 0.01$, from 20.0 to 30.6% of DM), whereas protein content tended to linearly increase ($P = 0.07$, from 23.0 to 28.8% of DM) as a litter size increased from 8 to 14 piglets at birth. However, litter size at weaning was not related to colostrum and milk composition. The average daily gain of piglets was not related to colostrum and milk composition. In conclusion, colostrum and milk compositions were influenced by AT, GH, parity of sows, and litter size at birth.

Key Words: colostrum, milk, production environment, sows

83 Transitional changes in gestation and lactation serum α-tocopherol, and postpartum colostrum and milk α-tocopherol and fat concentrations in multiparous sows. J. S. Jolliff* and D. C. Mahan, *The Ohio State University, Columbus.*

Because the neonatal pig has low body α-tocopherol and contents, an α-tocopherol source is necessary to prevent deficiency in these young animals. Two observational studies evaluated changes in serum α-tocopherol during late gestation and serum, colostrum, and milk α-tocopherol, along with milk fat, during lactation in multiparous sows. Gestating sows were fed 2.2 kg /d of a fortified corn soybean meal gestation diet with 22 IU of DL-α-tocopheryl acetate added per kg and no added fat. Lactating sows were adjusted to an ad libitum feed intake within 5 d postpartum and fed a fortified corn soybean meal diet containing 1.0% total lysine, 22 IU added dl-α-tocopheryl acetate per kg, and 5% added fat. Study 1 involved a total of 96 bleedings from 54 sows from 85d postcoitum through weaning (17 d). Serum α-tocopherol concentrations were relatively constant from 85 to 100 d postcoitum but then quadradically declined ($P < 0.01$) until parturition whereupon serum α-tocopherol concentrations linearly increased ($P < 0.01$) through weaning. In study 2, colostrum and milk were collected from 22 sows at 0, 2, 4, 6, 10, 14, 18, 24, 36, 48, 72, 96, 120, 144, and 168 h (7 d) postpartum and analyzed for d-α-tocopherol and fat. Colostrum and milk were collected from all functional glands after an i.m. injection of oxytocin. The α-tocopherol content of colostrum was relatively constant from parturition to 24 h postpartum and then declined until d 5 where it remained relatively constant. This resulted in an overall cubic ($P < 0.01$) response over the 7 d time frame. In contrast, colostrum and milk fat increased quadratically ($P < 0.01$) over time. Together, the results of these 2 studies imply that, during late gestation, serum α-tocopherol was transferred to the mammary tissue for inclusion into colostrum. After parturition, there was an inverse relationship between the α-tocopherol concentrations of colostrum and milk with α-tocopherol declining as lactation progresses.

Key Words: colostrum, milk, sow, vitamin E

84 Effects of dietary vitamin E level and source on sow, milk, and piglet levels of α-tocopherol. N. W. Shelton*[1], J. L. Nelssen[1], M. D. Tokach[1], S. S. Dritz[1], J. M. DeRouchey[1], R. D. Goodband[1], H. Yang[2], and D. C. Mahan[3], *[1]Kansas State University, Manhattan, [2]ADM Alliance Nutrition, Quincy, IL, [3]The Ohio State University, Columbus.*

A total of 126 gilts and sows (PIC 1050) and their litters were used to determine the effect of dietary vitamin E level and source on sow plasma, milk, and piglet concentrations of α-tocopherol. The 6 dietary treatments were 2 levels of dl-α-tocopherol acetate (Syn E) at 44 and 66 mg/kg, and 4 levels of d-α-tocopherol acetate (Natural E) at 11, 22, 33, and 44 mg/kg. From breeding to d 69 of gestation, sows were fed 2.0 kg/d of a diet containing 40% DDGS, 0.30 ppm added Se, and no supplemental vitamin E. Vitamin E treatments were fed from d 70 of gestation to weaning. Plasma was collected from sows on d 69 and 100 of gestation, at farrowing, and at weaning. Colostrum and milk samples (weaning) were also collected. Plasma from 3 pigs per litter and heart and liver samples from 1 pig per litter were collected at weaning (19.7 d). All samples from 6 litters per treatment were analyzed for α-tocopherol. Treatment effects were not observed ($P > 0.10$) for lactation feed intake, piglet BW or BW gain, or sow BW measures. As Natural E increased in the diet, sow plasma, colostrum, milk, piglet plasma, and piglet heart concentrations of α-tocopherol increased (linear; $P < 0.03$). Sows fed diets with 44 mg/kg Natural E had increased plasma, colostrum, and piglet plasma α-tocopherol concentrations ($P < 0.03$) compared with sows fed the 44 mg/kg of Syn E. Regression analysis indicated that the relative bioavailability coefficients for Natural E:Syn E ranged from 2.1 to 4.2 for sow and piglet plasma α-tocopherol, 2.9 to 3.0 for colostrum α-tocopherol, 1.6 to 7.3 for milk α-tocopherol, and 1.8 to 7.5 for heart and liver α-tocopherol. Overall, this study shows that the relative bioavailability for Natural E:Syn E varies depending on the response criteria but is greater than the standard value of 1.36 in sows.

Table 1. Tissue and plasma α-tocopherol, μg/mL, with 2 levels of synthetic vitamin E and 4 levels of natural vitamin E.

	Syn		Natural					Relative Bioavailability	
Vitamin E, mg/kg	44	66	11	22	33	44	SEM	44	66
Sow Plasma									
D 69	1.00	0.85	0.89	0.89	0.95	0.98	0.082		
D 100	1.32	1.51	1.09	1.28	1.64	1.99	0.187	2.1	2.4
Farrowing	0.72	0.87	0.75	0.86	1.01	1.19	0.120	4.2	3.0
Weaning	1.41	1.88	1.15	1.75	2.02	2.53	0.139	2.7	2.4
Colostrum	8.19	10.31	7.62	11.39	9.40	17.76	2.165	3.0	2.9
Milk	3.25	2.51	2.36	3.22	3.75	3.63	0.458	1.6	7.3
Weaned piglet									
Plasma	2.47	2.38	2.11	3.03	3.51	3.78	0.376	3.0	5.1
Heart	4.84	3.93	3.60	4.75	5.93	6.00	0.619	1.8	5.3
Liver	4.18	3.39	2.99	4.88	4.96	5.12	1.063	2.0	7.5

Key Words: α-tocopherol, bioavailability, natural vitamin E, sow

85 Quantifying time-varying efficiency of utilizing sow's milk for piglet growth. A. B. Strathe*[1], A. V. Hansen[1,2], E. Kebreab[1], and P. K. Theil[2], *[1]Department of Animal Science, University of California, Davis, [2]Department of Animal Science, Faculty of Science and Technology, Tjele, Denmark.*

The traditional expression of piglet growth efficiency is the milk conversion ratio (MCR) and it may be affected by milk yield (MY) and composition, resulting from inclusion of dietary fat into lactation diets. The objective of the study was to quantify the effects of different sources of fat on MY as well as time-varying effects on MCR. Forty-six sows were allotted to 1 of 6 diets based on barley, wheat, and soybean meal supplemented with 3% animal fat, 8% coconut oil, sunflower oil, fish oil or 4% fish oil + 4% octanoic acid. The sixth diet was added 2.5 g/d β-hydroxy-β-methyl butyrate as topdressing. Litter weight (LW) was recorded on d 7, 10, 14, 17 and 28 while MY was measured by the deuterium dilution technique on d 9, 16 and 23, respectively. The classical Wood function (i.e., $a \times t^b \times e^{-c \times t}$) was adopted for the analysis of the MY data while LW was modeled as a function of total milk intake (TMI) ($LW(t) = W_0 + k \cdot TMI(t)$) where TMI was derived as the integrated form of the Wood function. The parameter k (MCR = 1/k) describes the LW gain per kg milk ingested. The MY and LW data was modeled sequentially; first, a nonlinear mixed model was fitted to the MY data; second, sow specific parameters were plugged into the integrated Wood function, to compute the independent variable TMI(t) and then LW(t) was fitted to LW data. Both models incorporated fixed effect of diet and random effect of sow through the functional parameters while k also included time as a fixed effect, allowing k to change continuously during the suckling period. The dietary treatments did not affect the parameters of the Wood function, W_0 and k ($P > 0.10$). Significant changes in k were estimated during the suckling period ($P < 0.001$). The following relationship was derived k(t) = 0.283(SE = 0.0097) - 0.0016(SE = 0.00033)t. It was estimated that MCR were increasing from 3.69(SE = 0.10) at d 7 to 4.21(SE = 0.07) at d 28 of suckling. Population mean peak MY and time to peak MY were 12.9(SE = 0.23) kg/d and 19.3(SE = 1.03) days. The total MY was estimated to 299(SE = 22) kg during the 28 d lactation. In conclusion, the modeling framework quantified key aspects of piglet growth efficiency and sow lactational performance.

Key Words: lactation, sow, piglet, modeling

86 Dietary protein and amino acid requirements in lactating sows is estimated using population-based factorial approach. A. V. Hansen*[1,2], A. B. Strathe[1], E. Kebreab[1], and P. K. Theil[2], *[1]Department of Animal Science, University of California, Davis, [2]Department of Animal Science, Faculty of Science and Technology, Aarhus University, Tjele, Denmark.*

Estimation of protein and amino acid requirements for lactating sows is a central part of nutritional management of sow herds. The factorial approach is often used to determine the requirements for sows using an average sow to represent the herd. The objective of the study was to develop a population-based model for determination of amino acid and protein requirements for a population of lactating sows. The model inputs are the body weight of the sow and production targets, which are specified as litter size (LS) and gain (LG). The model was developed from existing literature data and individual sow data with longitudinal records of milk yield, composition and ME intake. The model used the Wood curve for representation of milk yield and ad libitum energy intake was represented by the monomolecular function. The functional parameters were drawn from multivariate normal distributions where their means were adjusted to production targets. The sow's energy intake is computed as her ad libitum ME intake and ME requirement. If the ad libitum ME intake is less than the ME requirement, the intake is set to ad libitum ME intake, otherwise the intake is the ME requirement. This way the sow is in either negative or zero energy balance. A population of 1,000 sows was simulated. An example is presented here where the inputs are set as follows: mean BW (200 kg) at parturition, LS (11 piglets) and LG (2.4 kg/d). The simulation resulted in mean daily apparent digestible lysine and protein requirement of 50.9 (5 and 95% percentiles: 41.8; 60.3) and 807 g/d (5 and 95% percentiles: 681; 937), respectively. The dietary requirement of apparent digestible lysine and protein relative to ME density was 0.64 (5 and 95% percentiles: 0.59; 0.68) and 10.1 g/MJ ME (5 and 95% percentiles: 9.61; 10.8), respectively. The results suggest that it is important to consider between sow variability when nutritional management is applied to a whole herd. Furthermore, incorporation of variability between sows eases the use of safety margins because a given percentile of the population's requirement is estimated.

Key Words: sow, requirement, amino acids, protein

87 The evaluation of supplemental L-arginine during gestation on sow reproductive performance. L. Greiner*[1], J. L. Usry[2], C. Neill[3], N. Williams[3], J. Connor[1], and G. Allee[4], *[1]Innovative Swine Solutions, LLC, Carthage, IL, [2]Ajinomoto Heartland, Inc, Chicago, IL, [3]PIC North America, Hendersonville, TN, [4]PorkTech, LLC, Columbia, MO.*

Two experiments were conducted to evaluate the feeding of supplemental L-arginine (Arg) in gestation on sow reproductive performance. Gestation diets consisted of corn and 40% corn dried distiller′s grains with solubles and were formulated to have 3.25 Mcal ME/kg, 0.53% SID lysine and all other nutrients to exceed recommendations (NRC, 1998). In both studies, sows were allocated as a randomized complete block and either fed diets with no supplemental L-Arginine or 28 g SID L-Arginine/d. In the first study, 376 gilts and multiparous sows (PIC, Camborough 29 and 1050) were fed the randomly assigned diets from d 18–34 of gestation and were blocked by parity, day of breeding and body condition. Sows were allocated an amount of feed based on body condition score with an average of 2.27 kg of feed/d. Conception rate (96.03 vs. 94.30%, respectively, $P > 0.46$), farrowing rate (91.52 vs. 89.16%, $P > 0.46$), and total born (12.94 vs. 13.00, $P > 0.87$) were

not significantly different between the control and the L-Arg treatment. In the second experiment, 316 multiparous sows (PIC, Camborough 29 and 1050) were allotted to one of 2 experimental diets at 75 d of gestation in blocks of parity and body condition. Sows were given a set amount of the respective dietary assignment based on body condition from d 75–115 of gestation (d 75–100 was 2.27 kg of feed/d and from d 100–112 was 3.18 kg of feed/d). The total born was not different between the 2 treatments (13.37 vs. 13.69, respectively, $P > 0.44$). However, total litter weight tended to be significantly different between the 2 treatments (19.63 vs. 18.96 kg, respectively, $P < 0.06$). In addition, individual pig weight was significantly different between the control and L-Arg diets (1.48 vs. 1.42 kg, $P < 0.05$). The data demonstrated that the supplementation of L-Arg in either early of late gestation did not improve sow reproductive performance, total born, or piglet birth weight.

Key Words: sow, gestation, arginine

88 Arginine supplement in early and late pregnant sows did not improve litter size or birth weight. C. E. Zier-Rush[1], A. Kuntzman[1], T. Schmidt[1], J. L. Usry[2], D. McKilligan[3], and R. D. Boyd*[1], *[1]The Hanor Company, Franklin, KY, [2]Ajinomoto Heartland Inc., Chicago, IL, [3]TechMix LLC, Stewart, MN.*

Three trials were conducted with pregnant sows to determine if L-Arginine (ARG) supplement of practical diets increase litter-size born or piglet birth weight. Treatments were provided as top-dress (TD, 0.23 kg/sow) to the gestation diet. The TD involved ground corn with 0 or 12.0% ARG; the latter provided 27.6 g supplemental ARG/sow/d. The basal diet was corn-soy based (18% middlings) and provided 3.29 Mcal NRC ME/kg and 0.51% SID Lysine. Other nutrients exceeded the NRC (1998). PIC Camborough sows were blocked by parity and allotted in a randomized block design. Early ARG supplement (Exp. 1) was fed to sows 18–34 d post-insemination (PI) and involved 2 replicates (Rep); n = 484 (litters 1–8) and 291 (litters 1–3). After 35 d PI, sows of similar body size were placed in pens (9–14 sows, 1.77 m^2/sow). Farrow rate was similar for each diet, however, gestation length increased slightly with ARG (+0.30 d, $P < 0.064$). Stillbirth was reduced in both Rep for ARG sows (0.30, 0.20 pigs/litter; $P = 0.0153$, $P = 0.0214$ respectively). Total pigs born was not different in Rep 1 (12.9/litter, $P > 0.70$). In Rep 2, total pigs averaged 12.8/litter with a trend for reduction in ARG sows (0.80 less, $P = 0.096$). In Exp. 2, the impact of ARG in late pregnancy (75–115 d PI) on piglet birth weight was determined with 393 sows (litters 1–8). Sows were housed and allotted to treatment as Exp. 1, except they were fed in pens after 35 d PI. TD was evenly applied as sows ate with TD common to the pen. Total pigs born and born alive was not different (12.8/litter, $P < 0.498$; 12.0, $P < 0.459$). Litters were weighed within 12 h of birth. No effect was observed for ARG on litter birth weight (avg 17.1 kg, $P = 0.935$). ARG did not increase piglet birth weight in a subset of litters, balanced for parity (n = 82): ARG, 1.41 vs. 1.45 kg/pig ($P = 0.079$) and litter-size did not change the result. We conclude that ARG supplement of practical gestation diets did not increase litter-size or litter birth weight under commercial conditions.

Key Words: sow, arginine, gestation

Physiology

89 Uteroplacental steroid flux in an ovine maternal nutrient restriction model during melatonin supplementation. L. E. Camacho*[1], C. O. Lemley[1], A. M. Meyer[2], D. M. Hallford[3], and K. A. Vonnahme[1], *[1]Department of Animal Sciences, North Dakota State University, Fargo, [2]Department of Animal Sciences, University of Wyoming, Laramie, [3]Department of Animal and Range Sciences, New Mexico State University, Las Cruces.*

Objectives were to examine the effects of dietary melatonin supplementation and nutritional plane on uteroplacental progesterone (P4) and estradiol 17β (E2) flux. From d 50 to 130 of gestation, 31 primiparous ewes were allocated to receive 100% (ADQ) or 60% (RES) of nutrient requirements and were supplemented with 5 mg of melatonin per day (MEL) or no melatonin (CON). At d 130, umbilical and uterine artery blood flow (BF) were determined under general anesthesia. Blood samples were collected from maternal saphenous artery (A), gravid uterine vein (V), umbilical artery (a), and umbilical vein (v). Steroid uterine flux (A-V × uterine BF), fetal flux (v-a × umbilical BF), and placental flux (uterine flux - fetal flux) were calculated. Melatonin supplementation did not alter steroid vessel concentrations or uteroplacental flux ($P > 0.07$).There was no effect ($P = 0.06$) of nutritional plane on maternal artery P4 concentrations; however, RES had greater E2 ($P = 0.002$) than ADQ. Uterine vein P4 and E2 were increased ($P < 0.001$) in RES vs. ADQ. Maternal AV difference for P4 was increased ($P < 0.0001$) by RES whereas E2 difference was not affected. Nutritional plane did not affect ($P \leq 0.17$) P4 or E2 of umbilical artery and vein or fetal va difference. There was an effect of nutritional plane ($P = 0.03$) on uterine flux, where P4 secretion rate was increased in RES vs. ADQ, while E2 uterine flux was unaffected ($P = 0.10$). Fetal flux of P4 was not affected ($P = 0.32$) by nutritional plane. There was a nutritional plane effect ($P = 0.05$) on fetal E2 flux, where ADQ had a net secretion of E2 and RES had a net consumption. There was an effect of nutritional plane ($P < 0.03$) on placental flux of P4, where placental secretion of P4 was greater ($P = 0.03$) in RES vs. ADQ. Nutritional plane had an effect ($P = 0.008$) on placental E2 flux, where ADQ had a net consumption of E2 and RES had a net secretion. Nutrient restriction increased placental P4 secretion, while placental E2 flux changed from net consumption to secretion, which may indicate altered placental steroidogenic enzyme expression and/or activity.

Key Words: gestational nutrition, steroids, utero-placenta

90 Uteroplacental flux of amino acids (AA) in adequately fed or nutrient restricted ewes supplemented with melatonin. C. O. Lemley*[1], L. E. Camacho[1], A. M. Meyer[2], M. Kapphahn[1], J. S. Caton[1], and K. A. Vonnahme[1], *[1]North Dakota State University, Fargo, [2]University of Wyoming, Laramie.*

Objectives were to examine uteroplacental AA flux during dietary melatonin supplementation in a maternal nutrient restriction model. From d 50 to 130 of gestation, 31 ewes were supplemented with 5 mg of melatonin per d (MEL) or no melatonin (CON) and allocated to receive 100% (adequate; ADQ) or 60% (restricted; RES) of nutrient requirements. On d 130 of gestation uterine and umbilical blood flows (BF) were determined under general anesthesia, and blood samples were collected from the maternal saphenous artery (A), gravid uterine vein (V), umbilical artery (a), and umbilical vein (v) for AA analysis. Uterine flux ([A − V] x uterine BF), fetal flux ([v − a] x umbilical BF), and uteroplacental flux (uterine flux − fetal flux) of AA (μmol/min) were calculated. Several vessel AA concentrations showed treatment differences; however, the following results focus specifically on those AA that showed treatment differences ($P < 0.05$) in uteroplacental flux. Maternal artery and uterine vein concentrations, for Asp and branched-chain AA (Ile, Leu, Val) were similar ($P > 0.05$) across treatment groups. Uterine production of Ile was decreased ($P < 0.05$) in RES vs. ADQ. Umbilical vein concentration of Asp was decreased ($P < 0.05$) in RES vs. ADQ, whereas umbilical vein concentrations of Ile and Leu were decreased ($P < 0.05$) in CON-RES vs. CON-ADQ and similar ($P > 0.05$) in MEL-RES vs. CON-ADQ. Melatonin treatment decreased ($P < 0.05$) umbilical artery branched-chain AA concentrations. Fetal production of Asp was increased ($P < 0.05$) in CON-RES vs. CON-ADQ and similar ($P > 0.05$) in MEL-RES vs. CON-ADQ. Fetal consumption of branched-chain AA were decreased ($P < 0.05$) in CON-RES vs. all other groups. Uteroplacental consumption of Asp was increased ($P < 0.05$) in MEL-ADQ vs. CON-ADQ, while uteroplacental production of branched-chain AA were decreased ($P < 0.05$) in CON-RES vs. CON-ADQ and similar ($P > 0.05$) in MEL-RES vs. CON-ADQ. Melatonin treatment partially improved uteroplacental AA flux in RES ewes to the level of CON-ADQ ewes, which may be mediated via increased placental blood perfusion and/or placental AA transporter density.

Key Words: amino acid flux, melatonin, utero-placenta

91 Mechanisms of medicinal herbs alleviation heat stress-induced male infertility in boars. C. C. Selby*, T. M. Taxis, P. Sutovsky, and W. R. Lamberson, *Division of Animal Sciences, University of Missouri, Columbia.*

Male reproductive performance is reduced by exposure to high ambient temperatures through compromised spermatogenesis and semen quality. *Artemisia afra* is a herb used by indigenous peoples of South Africa to alleviate effects of heat stress during desert travel and *Artemisia absinthium* (AA) is a related plant grown in the US Studies conducted in our laboratory have shown that AA alleviates heat-stress induced infertility in male mice. The aims of this experiment were to determine if AA alleviates heat stress induced infertility in boars. Six 8 mo old boars were assigned in a crossover design to a 1% wt/vol decoction (based on human usage for medicinal purposes) of AA or tap water (TW) for 5 d before a 5 d period at 32°C, or for non-heat stressed boars, at 21°C. Each boar was collected twice per week and semen analyzed for viability (live or dead sperm), mitochondrial membrane potential (MMP; determines mitochondrial activity inside the sperm cell), peanut agglutinin (PNA; binds to the outer acrosomal membrane and allows visualization of acrosomal integrity), and proteostate aggresome-ubiquitin (UBI; determines the level of ubiquitin, based on amount of aggresome bodies, which is responsible for degradation of damaged sperm cells). Rectal, scrotal, ear, and shoulder temperatures and liquid consumption were fitted to a repeated measures mixed model which included the effects of treatment, day, time of day, thermal environment and boar. Viability, PNA, UBI, and MMP were fitted to a repeated measures mixed model which included the effects of treatment, week and boar. Consumption of TW was higher than AA ($P = 0.007$). Rectal temperature increased daily throughout heat-stress ($P = 0.006$). The level of PNA decreased after heat stress ($P < 0.001$). Capacitated sperm decreased and normal sperm increased 4–5 wk after heat stress ($P < 0.001$). Mitochondrial membrane potential decreased ($P = 0.007$) after heat stress. Viability test showed that there was a

spike of debris ($P < 0.001$) in wk 4 and a decrease of live sperm in wk 2 ($P < 0.001$). There was no beneficial effect of AA on semen quality.

Key Words: boar, *Artemisia*, heat stress, fertility

92 Influence of post-AI supplementation on weight change and pregnancy success in beef heifers. K. L. Gebhart*, B. L. Perry, J. A. Walker, C. L. Wright, and G. A. Perry, *Department of Animal Science, South Dakota State University, Brookings.*

Research has shown that heifers moved from a feedlot to grass after breeding have decreased weight gains and pregnancy success compared with heifers developed on range. The objective of this study was to determine if supplementing heifers following AI would improve weight gain and pregnancy success. Feedlot developed Angus-cross heifers (n = 301) at 2 locations were synchronized with the 7-d CIDR protocol (d −7 100 µg GnRH and CIDR; d 0 25 mg PG and removal of CIDR). At location 1 (n = 143), estrus was detected for 72 h and heifers bred 12 h after detection in estrus; heifers not in estrus were bred at 72 h with an injection of GnRH. At location 2 (n = 158), animals were fixed-time inseminated at 54 h after CIDR removal. At time of insemination heifers were randomly assigned to one of 2 treatments: 1) moved to pasture (PAST), or 2) moved to pasture and supplemented with 2.22 $kg \cdot hd^{-1} \cdot d^{-1}$ of dried distillers grains plus solubles (SUPP). Weights and BCS were determined on d 3 and 45. There was a treatment ($P < 0.01$) and a treatment by herd interaction ($P < 0.01$) on weight change from d 3 to 45, but no effect of herd ($P = 0.17$). At location 2, SUPP heifers gained more ($P < 0.01$) weight than PAST heifers from d 3 to 45, but at location 1, there was no difference ($P = 0.79$). There was no effect of treatment ($P = 0.87$), but there was an effect of herd ($P < 0.01$) and a treatment by herd interaction ($P = 0.01$) on BCS change. Heifers at location 1 lost more condition than heifers at location 2, but at both locations PAST heifers tended to lose more condition than SUPP heifers ($P = 0.10$ and 0.07, respectively). Pregnancy success was affected by treatment ($P = 0.02$), with SUPP heifers having increased pregnancy success compared with PAST heifers. However, there was no effect of herd ($P = 0.64$), treatment by herd ($P = 0.21$), BCS at AI ($P = 0.40$), or weight change from AI to pregnancy determination ($P = 0.47$). In summary, supplementing feedlot developed heifers when moved to pasture at AI increased weight gain and improve pregnancy success.

Key Words: fertility, heifer, post-AI nutrition

93 Dried distillers grains with solubles as a non-forage fiber source in lactating dairy cow diets. S. D. Ranathunga*, K. F. Kalscheur, A. R. Hippen, and D. J. Schingoethe, *South Dakota State University, Brookings, South Dakota.*

Dried distillers grains with solubles (DDGS) are a valuable source of energy for dairy cows, due to its high concentration of digestible fiber and fat. It is recommended that DDGS can be fed up to 20% without having any negative impacts. However, there are challenges to overcome when using DDGS in dairy cow diets. Low effectiveness of the non-forage fiber in the DDGS is one of these concerns. This may reduce the degradability of DDGS in the rumen to yield lower NEL when fed with low forage fiber diets. The objective of our work was to investigate the ability of using DDGS in dairy cow diets as a non-forage source under different feeding conditions. First, we examined the effect of feeding DDGS (18% DDGS) under different forage concentrations (17% vs. 24% forage NDF) with comparison to diets with corn starch (0% DDGS). Results suggested that lactating dairy cows fed DDGS performed similarly to diets fed corn starch. Also, it showed that inclusion of DDGS may not be the primary cause of milk fat depression, but rather the concentration of forage in the diet. Second, we evaluated the effect of forage and DDGS concentration on fermentation pattern in the rumen. This showed that forage and DDGS concentration affects ruminal fermentation and blood parameters, but not the total tract digestibility. Third, in situ degradabilities of DDGS and TMR containing different DDGS and forage concentrations were investigated under different ruminal conditions. This showed that NDF of DDGS and TMR containing DDGS decreased in degradability under low forage fiber conditions. These studies revealed that DDGS fermented differently under different ruminal conditions. This may explain a possible mechanism of behavior of DDGS under different forage conditions. Small, dense DDGS particles may escape the rumen rapidly and lead to an underestimation of NEL of DDGS under low forage conditions. Conversely, compact rumen mat under high forage fiber conditions may retain DDGS for a longer time to increase the fiber digestibility and yield greater NEL. These data suggest that DDGS perform better under favorable ruminal conditions.

Key Words: distillers grains, non-forage fiber, rumen

94 Influence of dietary cobalt supplementation and vitamin B_{12} injections in dairy cattle. M. S. Akins*[1], S. J. Bertics[1], M. T. Socha[2], and R. D. Shaver[1], *[1]University of Wisconsin-Madison, Madison, [2]Zinpro Corporation, Eden Prairie, MN.*

A study was conducted to determine lactation performance and metabolism of dairy cows fed different Co levels and sources or given weekly vitamin B_{12} (B_{12}) injections. Forty-five primiparous and 45 multiparous Holstein cows 60 d prepartum were blocked by parity (1 or > 1) and expected calving date, then randomly assigned 1 of 5 treatments in a randomized complete block design. The treatments were no supplemental Co (Control), 25 mg Co from Co carbonate (CoCarb), 25 mg (LCoGH) or 75 mg (HCoGH) Co from Co glucoheptonate, and Control plus weekly 10 mg B_{12} injections (IB12). Cows were on trial until 150 DIM. Cobalt (ppm DM) in the lactation diet was 1.0, 1.9, 2.3, and 5.2 for Control, CoCarb, LCoGH, and HCoGH, respectively. Far-off, close-up, and lactating diets were 13.8, 15.1, and 18.0% CP and 48.8, 40.2, and 32.9% NDF (DM basis), respectively. Intake during lactation was not affected ($P > 0.10$) by treatment and was 19.4 ± 0.5 and 23.1 ± 0.8 kg DM/d for primi- and multiparous cows, respectively. Fat-corrected milk was not affected ($P > 0.10$) by treatment for primiparous cows (35.4 ± 1.4 kg/d), but multiparous cows fed CoCarb (42.3 ± 1.7 kg/d) produced less ($P = 0.03$) than LCoGH (47.5 ± 1.8 kg/d). Milk fat and protein yield tended to be greater ($P \leq 0.10$) for multiparous cows fed LCoGH than CoCarb. Milk B_{12} was higher for IB12 ($P < 0.01$) than the other treatments. Cobalt addition increased ($P = 0.01$) milk B_{12} compared with Control. Plasma B_{12} was affected by a treatment by time interaction ($P < 0.01$) with IB12 highest at calving, then decreased at 30 DIM with the other treatments unchanged during the study. Liver B_{12} was greater ($P = 0.01$) for IB12 than the mean of LCoGH and HCoGH. Plasma glucose, nonesterified fatty acids, and β-hydroxybutyrate were not affected by treatment ($P > 0.10$). Addition of Co or injections of B_{12} did not affect lactation performance or energy metabolism of dairy cows, but influenced B_{12} in milk, plasma, and liver.

Key Words: cobalt, vitamin B_{12}, dairy cows

95 Effect of a novel bovine colostrum-derived immunoglobulin G (IgG) source on serum IgG concentrations of newborn Holstein calves. D. B. Carlson*[1], C. A. Kost[1], E. Crouzer[2], R. W. Pelzel[2], and M. T. Socha[2], *[1]Milk Products, Chilton, WI, [2]Zinpro Performance Colostrum, Eden Prairie, MN.*

The objectives of this study were to determine the effects of feeding colostrum replacer (CR) formulated with a novel bovine colostrum-derived IgG source on serum IgG concentration, apparent efficiency of IgG absorption (AEA), and ability to achieve passive transfer of immunity in newborn Holstein calves. At birth, 20 male calves were randomly assigned to CR treatments that contained 130 (CR130) or 150 g (CR150) of IgG derived from dried bovine colostrum. CR130 contained 22% fat, CR150 contained 19% fat, and both CR contained equivalent supplemental vitamin and mineral concentrations. Calves were weighed and blood was sampled within 1.5 h of birth before CR feeding. Within 2 h of birth, 500 g of CR was reconstituted with 1.7 L of warm water and fed via nipple bottle. Any refused volume was fed via esophageal feeder. Blood was sampled again at 24 h after CR feeding. Serum IgG concentrations were determined via single radial immunodiffusion, and adequate passive transfer of immunity was defined as serum IgG ≥10 mg/mL. Six CR130 calves and 3 CR150 calves consumed the entire CR volume via nipple bottle. Average voluntary consumption was 1.4 L for CR130 and 1.0 L for CR150. Birth weight tended ($P = 0.11$) to be greater for CR150 (42.0 kg) compared with CR130 (38.7 kg); however, birth weight was not a criteria used for treatment assignments. Average serum IgG was greater ($P < 0.01$) than 10 mg/mL for both CR130 (12.6 mg/mL) and CR150 (14.6 mg/mL) treatments with calves fed CR150 having higher serum IgG concentrations ($P \leq 0.01$) than calves fed CR130. Nine calves (90%) in the CR130 group and 10 calves (100%) in the CR150 group had adequate passive transfer of immunity (serum IgG ≥10 mg/mL). AEA did not differ ($P = 0.28$) between CR130 (37.1%) and CR150 (40.5%) groups. Results from this study indicate that feeding CR containing either 130 or 150 g of IgG from a novel source of dried bovine colostrum met or exceeded the industry benchmark for percentage of calves with adequate passive transfer of immunity (≥90%). Further, increasing IgG intake increased serum IgG concentrations without affecting AEA.

Key Words: calves, colostrum replacer, immunoglobulin

96 Probiotics cultures in animal feed: Effects on ruminal fermentation, immune responses, and resistance to infectious diseases. M. A. Osman*[1,2], J. R. Stabel[3], J. M. Hostetter[4], D. Nettleton[5], S. E. Dowd[6], K. Onda[7], W. Kreikemeier[8], D. Ware[8], and D. C. Beitz[1,9], *[1]Department of Animal Science, Iowa State University, Ames, [2]Interdepartmental Program of Immunobiology, Iowa State University, Ames, [3]USDA-ARS-National Animal Disease Center, Ames, IA, [4]Department of Veterinary Pathology, Iowa State University, Ames, [5]Department of Statistics, Iowa State University, Ames, [6]Research and Testing Laboratory, Lubbock, TX, [7]Department of Internal Medicine, Azabu University, Sagamihara, Kanagawa, Japan, [8]Nutrition Physiology Company, Guymon, OK, [9]Department of Biochemistry, Biophysics, and Molecular Biology, Iowa State University, Ames.*

We evaluated the effects of probiotics included in dairy cattle and mice feed on ruminal fermentation, immune responses, and resistance to Johne's disease. To unveil the underlying mechanisms, dairy cattle were either fed Bovamine (1.04×10^9 cfu of *Lactobacillus acidophilus* NP51 plus 2.04×10^9 cfu of *Probionibacterium freudenreichii* NP24) or lactose carrier top-dressed onto a total mixed ration for 6 weeks. Feeding Bovamine advantageously modified the digestive system microbiome as determined by the bacterial tag encoded FLX amplicon pyrosequencing technique compared with that of the control cows fed the lactose carrier. Ruminal Firmicutes: Bacteroides tended ($P = 0.06$) to increased, indicative of increased energy harvest in rumen. As a result, concentrations of VFA significantly ($P \leq 0.005$) increased in the rumen. Also, in murine model of Johne's disease, viable or heat-killed NP51 (VNP51 or HNP51, respectively) fed at 1×10^6 cfu·mouse^{-1}·day^{-1} to Balb/c mice challenged with 108 cfu of either viable or heat-killed *Mycobacterium paratuberculosis* (VMAP or HMAP, respectively), the causative agent of Johne's disease differentially stimulated the adaptive immunity and decreased ($P \leq 0.05$) tissue MAP burden and fecal MAP shedding. With VMAP as the inoculum, both VNP51 and HNP51 stimulated CD8+ immune cell-mediated immunity and decreased the humoral immunity. With HMAP as the inoculum, VNP51 stimulated the CD8+ immune cell-mediated and the humoral immunity and HNP51 induced CD8+ immune cell-mediated immunity only. Overall, feeding NP51 to mice alleviated symptoms of Johne's disease and feeding NP51 along with NP24 (Bovamine) to dairy cattle increased ruminal VFA concentrations and thus dietary energy capture via favorably transforming their digestive system microbiome.

Key Words: probiotics, microbiome, ruminal fermentation, Johne's disease

97 Effects of supplementing PetroAlgae's Lemna Meal vs. alfalfa meal on nutrient intake, milk yield and milk fatty acid profile in lactating dairy cows. D. N. L. da Silva*[1], M. Rohlfsen[2], D. Wells[2], and N. B. Litherland[1], *[1]University of Minnesota, St Paul, [2]PetroAlgae LLC, Melbournce, FL.*

PetroAlgae's Lemna Meal (LM), a by-product from bio-fuel production using duckweed, is a novel feed that has potential in animal diets. Our objectives were to determine the effects of LM on; dry matter intake (DMI), milk yield (MY) and milk fatty acids. Our hypothesis was that cows fed LM would have similar DMI and milk yield compared with alfalfa (A). Thirty-six multiparous Holstein and crossbred (Holstein × Montbeliard × Swedish Red) dairy cows were fed dietary treatments; 1) A; TMR with alfalfa pellets (16.2% CP; 1.6 Mcal/kg of NE_L, 34.7% NDF) or 2) LM; TMR with LM pellets (16.2% CP; 1.6 Mcal/kg NE_L, 33.4% NDF). Treatments were balanced by MY (48.6 ± 1.4 kg/d), days in milk (79.3 ± 7.8 d), and body weight (614 ± 16.6 kg). Cows were housed in tie stalls, fed once and milked twice d. LM and A were pelleted by mixing (25% DM basis) of A or LM with wheat middlings, corn DDGS, soy hulls, molasses, and soy oil. A and LM pellets replaced 22% of the DM in the TMR. Data were analyzed using MIXED in SAS in a crossover design with 21 d periods. DMI was similar between treatments ($P = 0.28$) and averaged 25.6 and 24.6 ± 0.7 kg/d for A and LM. MY and 3.5% FCM were similar; 41.6 and 41.2 ± 1.1 kg/d and 38.5 and 38.7 ± 0.9 Kg/d for A and LM. Dairy efficiency was similar averaging 1.54 and 1.61 ± 0.1 for A and LM. Milk fat (3.1 vs. 3.2 ± 0.1%) and protein (3.0 vs. 2.9 ± 0.1%) concentration were not different for A and LM respectively. Milk fatty acid analysis was conducted on a subset of cows (n = 18). Milk fat yield of butyrate from LM was higher ($P < 0.05$) (40.5 vs. 49.6 ± 2.5 g/d) than that from A. Proportion of monounsaturated fat tended ($P = 0.07$) to be higher in LM vs. A (0.7 vs. 0.8 ± 0.01). Diet did not affect proportion of n-3 fatty acids, saturated fat or *trans*-fat in milk. This study confirmed that dried LM at 5.5% of diet DM is an attractive alternative to alfalfa meal for dairy cows. The fatty acid profile of LM presents an opportunity to alter the lipid composition of milk.

Key Words: Lemna Meal, byproduct feed, dairy cow, milk fatty acids

98 Evaluation of feed delivery methods for transitioning prepubertal dairy heifers to higher forage diets. T. S. Dennis*, J. E. Tower, and T. D. Nennich, *Purdue University, West Lafayette, IN.*

Feeding strategies that improve growth and feed efficiency when transitioning post-weaned dairy heifers to the growing period may accelerate development. The objectives of this study were to evaluate the effects of feed delivery method on growth, dry matter intake (DMI), feed efficiency, and rumen parameters of prepubertal dairy heifers transitioning to higher forage diets. Ninety Holstein heifers (151.0 ± 15.5 kg, 136 ± 26 d of age) were randomly assigned to 1 of 15 pens by body weight (BW). Treatment diets contained 40% forage and 60% grain mix (DM basis) and were delivered using a hay feeder and grain bunk (HF), forage and grain fed side-by-side (SBS) in a bunk, or a total mixed ration (TMR) for 28 d. Heifers were weighed weekly, with hip and withers heights, heart girth circumference (HGC), and body condition score (BCS; 1 to 5 scale) measured every 2 wk. Blood and rumen fluid were collected every 2 wk to measure plasma urea N, glucose, rumen ammonia and pH. Data were analyzed as repeated measures using the MIXED procedure of SAS with pen as the experimental unit. Delivery method affected final BW, as HF heifers were 5.1 kg heavier than TMR heifers after 28 d ($P = 0.02$). Average daily gains were lower for TMR compared with HF and SBS (0.56 vs. 0.79 and 0.76 kg/d, respectively; $P = 0.05$). Average DMI was similar between delivery methods throughout the study (4.3 kg/d; $P > 0.1$). However, DMI was least for SBS (5.0 kg/d) and greatest for HF and TMR (5.5 and 5.6 kg/d, respectively) at the conclusion of the study ($P < 0.01$). Overall gain:feed improved for HF and SBS compared with TMR (0.102 and 0.103 vs. 0.085 kg/kg, respectively; $P = 0.05$). Hip and withers heights, HGC, BCS, blood metabolites, and rumen pH were not affected by delivery method ($P > 0.1$). Rumen ammonia was significantly greater for SBS compared with HF at 14 d (23.9 vs. 17.9 mg/dL; $P = 0.02$), but was similar between delivery methods at 28 d ($P > 0.1$). Results from this study showed that component fed diets improved average daily gain and feed efficiency compared with TMR when transitioning prepubertal heifers to higher forage diets.

Key Words: dairy, heifer, feed delivery

99 Handling techniques of forage diet samples collected using fistulated cattle. S. K. Pruitt*, B. L. Nuttelman, C. J. Schneider, J. A. Musgrave, L. A. Stalker, and T. J. Klopfenstein, *University of Nebraska, Lincoln.*

Handling techniques of forage diet samples collected using fistulated cattle to determine forage quality may inaccurately represent nutrient composition because the technique used in squeezing saliva or liquids out of diet extrusa samples may cause losses of cell solubles. This was evaluated by using NDF analysis to quantify the non-soluble portion of fiber remaining in squeezed (SQ) and un-squeezed (UNSQ) samples. Four diet sample trials were performed using ruminally fistulated steers (n = 6) that were completely evacuated. Treatments included pre-ingested samples (PRE) when animals were fed cut forages in addition to 2 diet sample handling techniques SQ and UNSQ. In 2 diet sample trials: 1) ground hay and 2) mid-May fresh clipped smooth bromegrass were fed to ruminally fistulated steers (n = 6 and 5, respectively) with PRE, SQ, and UNSQ samples collected and analyzed for NDF. Two additional diet sample trials on smooth bromegrass pastures 1 and 2 that were grazed by yearling steers and sampled repeatedly (n = 4 and 6 d, respectively) between May and October 2011 were analyzed for handling techniques, SQ and UNSQ. Squeezed and UNSQ diet samples were collected from 3 paddocks within pasture 1 using 2 ruminally fistulated steers per paddock and 2 paddocks within pasture 2 using 3 ruminally fistulated steers per paddock. Ground hay NDF content was not affected ($P = 0.12$) by sample handling techniques (67.29%, 68.96%, and 66.21% for PRE, SQ and UNSQ, respectively). Handling techniques of fresh clipped bromegrass resulted in NDF differences ($P < 0.01$) between SQ and UNSQ (63.56% and 58.48%, respectively) diet samples. Similarly, NDF content differed ($P < 0.01$) when comparing SQ and UNSQ diet samples that were collected from pasture 1 (62.29% and 55.51%, respectively) and pasture 2 (60.23% and 52.35%, respectively). Handling technique did not affect ground hay NDF. However, NDF content was affected by SQ and UNSQ handling techniques of smooth bromegrass diet extrusa samples.

Key Words: forage diet sample, forage quality, NDF

100 Effects of forage type, storage method, and moisture level in crop residues mixed with modified distillers grains. B. M. Weber*, B. L. Nuttelman, K. R. Rolfe, C. J. Schneider, G. E. Erickson, T. J. Klopfenstein, and W. A. Griffin, *University of Nebraska, Lincoln.*

Two growing experiments were conducted to evaluate diets consisting of wheat straw (WS) or cornstalks (CS) mixed with modified distillers grains with solubles (MDGS) when ensiled or mixed fresh daily. Wheat straw based diets were also compared at different moisture levels (50% and 70%) when ensiled or mixed and fed fresh. In Exp. 1, 60 individually fed crossbred steers (289 ± 10 kg) were used in a CRD with 2 separate 2 × 2 factorials. Steers fed ensiled diets had greater DMI ($P = 0.03$) than steers fed diets mixed fresh daily. Storage method x residue type interactions ($P < 0.02$) were observed for ADG and G:F. Steers fed ensiled WS blends gained 0.59 kg/d and were similar to fresh CS (0.54 kg/d) and ensiled CS (0.50 kg/d) diets. Steers fed fresh mixed WS blends gained the least (0.42 kg/d) and were the least efficient (0.084). Steers fed fresh mixed CS:MDGS diets were more efficient (0.116) than those fed ensiled CS:MDGS mixtures (0.097), while ensiled WS:MDGS blends were more efficient (0.108) than fresh mixed WS treatments (0.084). Moisture level did not affect performance. In Exp. 2, 510 crossbred steers (316 ± 23 kg) were used in a RCBD (3 blocks, 34 pens) to evaluate growth performance and forage replacement of the Exp. 1 treatments. Residue:MDGS mixtures and a basal forage diet (60:40 alfalfa:grass hay) were offered ad libitum each day in separate feedings. Forage type x storage method interactions ($P < 0.05$) were observed for mixture DMI, forage DMI, and percent of total DMI. Steers offered supplemental CS:MDGS and freshly mixed WS:MDGS diets had higher intakes than those offered ensiled WS:MDGS blends and greater replacement of basal forage. Diets mixed fresh daily resulted in greater ADG ($P \leq 0.01$) and G:F ($P \leq 0.02$) compared with ensiled mixtures, while moisture level had no effect. All treatments except for 70% moisture ensiled WS replaced 22.2% or more of the basal forage intake and improved ADG and G:F relative to steers receiving only the basal diet.

Key Words: cattle, growing, crop residue, distillers grains

101 Summer supplementation and subsequent feedlot sorting of yearling steers. K. M. Rolfe*, W. A. Griffin, T. J. Klopfenstein, D. R. Mark, B. L. Nuttelman, and G. E. Erickson, *University of Nebraska, Lincoln.*

Effects of supplementing modified wet distillers grains with solubles (MDGS) during summer grazing and subsequent feedlot sorting on long yearling steer performance were evaluated. Each year of a 3-yr study, 240 crossbred steers (initial BW = 226 ± 9 kg) were used in a completely randomized design with a 2 × 2 factorial treatment arrangement. At the time of summer grazing (136 d), steers were assigned randomly to 1 of 2 treatments: 1) grazing native range with no supplement (CON); or 2) grazing native range with MDGS supplementation at 0.6% BW (DM; SUPP). After summer, steers were assigned randomly within grazing treatment to 1 of 2 feedlot sorting treatments: 1) sorted 3 ways based on distribution of feedlot entry BW (25% light, 50% medium, 25% heavy; SORT); or 2) not sorted, but serially harvested in 2 groups to allow for retrospective adjustment to a constant endpoint (NOSORT). During summer grazing, SUPP had 0.30 kg greater ($P < 0.01$) ADG and were $9.81/steer more ($P = 0.02$) profitable than CON. At feedlot entry, SUPP were 48 kg heavier ($P < 0.01$) than CON. Feedlot ADG tended to be greater ($P = 0.07$) for CON than SUPP, but G:F and DMI were not different ($P > 0.16$). Supplemented steers were fed 24 d less ($P < 0.01$) to reach a similar 12th rib fat thickness as CON, had greater ($P = 0.01$) LM area, and lower ($P < 0.01$) marbling. Overall system economics revealed SUPP tended ($P = 0.06$) to be more profitable than CON when sold live and was $18.14/steer more ($P < 0.01$) profitable when marketed on a grid. Sorting on feedlot entry BW increased ($P < 0.05$) HCW 5 kg for SORT compared with NOSORT; but percentage carcasses over 454 kg was similar ($P = 0.80$). Feedlot and overall system profitability was not different ($P > 0.35$) between sorting treatments. Supplemental MDGS increases cattle gain during summer grazing, decreases days fed in the feedlot, and improves overall profitability of this system. Sorting yearling steers on feedlot entry BW increases weight sold at harvest.

Key Words: steers, supplement, sorting, economics

102 Stocking system effects on soil and forage characteristics and performance of fall-calving cows grazing tall fescue pastures. M. W. Dunn*, J. R. Russell, D. G. Morrical, S. K. Barnhart, and H. J. Sellers, *Iowa State University, Ames.*

A 2-year trial tested the effects of increasing stocking density of beef cows grazing pastures at a constant forage allocation. Six 4.05-ha tall fescue (*Festuca arudinacea* Schreb) pastures, divided into 10 0.405-ha paddocks, were assigned to one of 3 treatments: rotational stocking (RS), strip stocking (SS), or mob stocking (MS). Sixty fall-calving

Angus cows (BW 604 kg and BCS 4.85, 9-point scale) in late gestation were blocked by BW and BCS and 10 were allotted to each pasture. Live forage allowances (LFA) measured with a falling plate meter (4.8 kg/m^2) were 4 and 3.2% of cow BW/d in yr 1 and 2, respectively. Cows in RS pastures grazed an entire paddock and were moved when 50% of the live forage DM was removed (yr 1) or after a residency time based on initial sward height and LFA (yr 2). Paddocks in SS and MS pastures were divided into strips providing 100 and 25% of the daily LFA, which were offered one and 4 times daily, respectively. Cow BW and BCS were measured monthly. Calves were weighed at birth and at termination of grazing. Forage samples were hand-clipped to 2.5 cm at 3 0.25-m^2) sites per paddock monthly, hand-sorted into live grass, weed, legume, and dead forage fractions, dried at 65°C for 48 h, and analyzed for IVDMD and CP. In May, July, and October, soil OM and bulk density (SBD) to a depth of 7.5 cm and soil penetration resistance at 1-cm intervals to 15 cm (PR, yr 2 only) were measured at 3 sites per paddock, and water infiltration rate (IR) at a 5-cm ponding depth for 90 min was evaluated at 2 sites per paddock. Cow BW and BCS, calf birth weight and ADG, pre-grazing forage sward height and live forage mass, SBD, PR, and IR did not differ between treatments in any month in either year ($P > 0.10$). Increasing stocking density had few effects on animal performance, forage mass, and soil compaction in the first 2 years of implementation.

103 Nutritive value and amount of corn plant parts. A. L. McGee*, M. C. Johnston, K. M. Rolfe, J. L. Harding, and T. K. Klopfenstein, *University of Nebraska, Lincoln.*

To determine the yield, quality, and quantity differences over time between fall grazed, spring grazed and ungrazed corn residue, we collected 10 corn plants preharvest from 24 locations within a field. The field was irrigated by a linear move irrigation system and maintained in a corn–soybean rotation, with grazing history maintained for 13 yrs. Over the past 7 years the soybean yields have been (kg/ha): fall grazed, 3818, 4604, 4631, 4367, 4624, 4986, 3686; spring grazed, 3946, 4530, 4558, 4309, 4424, 4817, 3580; and ungrazed, 3831, 4416, 4544, 4292, 4263, 4781, 3573. Corn yields, year following soybeans, were (kg/ha): fall grazed, 11255, 11585, 12490, 12734, 11901, 16386, 14880; spring grazed, 11363, 11693, 12488, 12219, 11899, 16046, 14988; and ungrazed, 11585, 11666, 12234, 12355, 11753, 16040, 14584. The yield was similar across the 3 grazing treatments for soybean ($P = 0.35$) and corn ($P = 0.30$) yield. The plants were divided into 7 different parts: leaf, leaf sheath, husk, shank, cob, top 1/3 stalk, and bottom 2/3 stalk. We measured IVDMD, kg DM of plant part/25.5 kg of grain, and percentage of the plant. We found no difference between the 3 different grazing treatments for digestibility or percentage of plant. Husk was the most digestible at 61.2% followed by shank (46.9%), leaf (44.9%), cob (41.3%), leaf sheath (40.8%), top 1/3 stalk (37.2%), and bottom 2/3 stalk (34.0%). As a percentage of plant weight, the bottom 2/3 was the largest part, making up 41.83% of the plant, followed by leaf, (18.72%), cob (14.68%), leaf sheath (12.60%), husk (7.48%), top 1/3 (3.60%), and shank (1.09%). Assuming cattle only select the most digestible parts of the corn residue and only consume leaf, leaf sheath, and husk, the amount available to them was 5.9 kg DM per 25.5 kg of corn at 15.5% moisture.

Key Words: corn residue, IVDMD, plant parts

104 Replacement of grazed forage and animal performance when distillers grains are fed in a bunk or on the ground. K. L. Gillespie*, T. J. Klopfenstein, J. A. Musgrave, B. L. Nuttelman, C. J. Schneider, L. A. Stalker, and J. D. Volesky, *University of Nebraska, Lincoln.*

A completely randomized grazing experiment estimated forage savings and ground feeding efficiency when supplementing spayed yearling heifers with modified distillers grains (MDGS) on native range. Heifers (n = 24, BW = 259 ± 42 kg) grazed Sandhills range 120 d beginning May 18, 2011. Treatments included no supplementation (CON), ground-fed MDGS at 0.6% BW (GRD), or bunk fed MDGS at 0.6% BW (BNK). There were 4 heifers per replication with 2 replications per treatment. Each treatment group rotated through 6 one-hectare paddocks. Rotation length was longer for grazing cycle 2 due to forage growth stage. A 17% forage savings from MDGS supplementation at 0.6% BW was assumed based on smooth bromegrass research. Thus supplemented groups grazed their paddocks 17% longer than CON each rotation. In cycle 2, all early, middle, and late rotationally grazed paddocks were hand-clipped to determine residual forage. Diet samples were collected via esophageally fistulated cows at mid-point of the grazing period to estimate forage quality over the grazing season. Supplemented cattle gained more per day ($P < 0.05$) and had greater ending weights ($P < 0.05$) than CON. There was no difference in daily gain ($P = 0.28$) or ending weight ($P = 0.91$) between GRD and BNK treatments. Daily gains were 0.53, 1.1, and 1.14 kg/d for CON, GRD and BNK respectively, with final BW's of 329, 398, and 400 kg, respectively. A retrospective analysis determined 4.3% of offered MDGS was lost when ground fed. There was no difference ($P = 0.38$) in residual forage. This illustrates equal grazing pressure by supplemented and unsupplemented heifers and verifies forage savings hypothesis when supplementing yearlings with MDGS at 0.6% BW. MDGS at 0.6% BW can be fed to decrease forage consumption 17%, increase summer grazing gains, and increase ending weights. A 4.3% loss of MDGS occurred when fed on the ground.

Key Words: beef cattle, supplement, bunk

105 Strategic supplementation of dried distillers grains to yearling steers grazing smooth bromegrass pastures. S. K. Pruitt*, C. J. Schneider, B. L. Nuttelman, W. A. Griffin, D. B. Burken, T. J. Klopfenstein, G. E. Erickson, and W. H. Schacht, *University of Nebraska, Lincoln.*

Supplementation of dried distillers grains plus solubles (DDGS) to yearling steers grazing smooth bromegrass has shown that strategic supplementation may increase overall ADG as forage quality declines over the growing season. The effect of daily supplementation strategies of DDGS on cattle performance were evaluated over 2 yr using yearling steers (n = 129; 301 ± 8 kg) grazing smooth bromegrass pastures. Treatments included: 1) paddocks fertilized (FERT) at 90 kg N/ha stocked at 9.9 AUM/ha, 2) non-fertilized paddocks (CON) stocked at 6.8 AUM/ha, 3) DDGS supplementation at 0.6% BW (SUPP) stocked at 9.9 AUM/ha and 4) DDGS strategic supplementation (STRAT) on non-fertilized paddocks stocked at 9.9 AUM/ha. Strategic treatment involved an incremental increase in DDGS supplementation to correspond with the declining forage quality over the growing season with design to provide the same total amount of DDGS (DM) over the grazing period as SUPP. Paddocks were divided into 6 strips and managed on a rotational system over 5 cycles. Supplement amounts for SUPP and STRAT were based on BW collected at the end of each of 5 cycles. Pastures were grazed for 147d and 168d for yr 1 and 2, respectively. Grazing pressure was maintained among treatments within yr with the use of put-and-take cattle. Paddock was the experimental unit with CON, SUPP and FERT replicated 4 times and STRAT replicated 3

times within each of 2 consecutive yr. Final BW and ADG differed ($P < 0.01$) among treatments. Daily gains for CON and FERT were not different ($P = 0.07$; 0.90 and 0.84 kg/d, respectively), but had lower ADG ($P < 0.01$) compared with STRAT and SUPP. Supplementation at 0.6% BW had the highest ADG at 1.19 kg/d and were similar ($P = 0.14$) to STRAT at 1.09 kg/d. Supplementation of DDGS improved ADG compared with FERT and CON. Strategic supplementation with incremental levels of DDGS did not increase ADG or final BW when compared with steers supplemented at 0.6% BW.

Key Words: dried distillers grains, grazing, supplementation

106 Effect of feeding distillers dried grains with solubles during lactation on cow performance, milk composition and pre-weaning progeny performance. C. N. Shee*, R. P. Lemenager, M. C. Claeys, and J. P. Schoonmaker, *Purdue University, West Lafayette, IN.*

Angus × Simmental cows (n = 54, BCS = 5.17 ± 0.06, BW = 653 ± 9 kg) with male progeny were fed 1 of 2 forage-based diets supplemented with: distillers grains (DDGS, n = 27) or soybean meal (SBM, n = 27), from calving to mid-lactation (129 d postpartum) to determine effects of DDGS on cow performance, milk composition and calf growth. Diets were formulated to be isocaloric (0.95 Mcal/kg NEg) but differed in CP (19.4 vs. 11.7%). Cow-calf pairs were allotted by calf birth date, BW and breed and by cow age and breed. At the termination of the study (129 d postpartum), cow-calf pairs were fed and managed as one group. Cow starting BW, BCS and calf birth weight did not differ between treatments ($P > 0.90$). Cow BW ($P \geq 0.43$) and BCS ($P \geq 0.13$) did not differ for the study. A weigh-suckle-weigh was performed on d 64 and d 110 postpartum to assess milk production and milk was collected on d 68 and d 116 for analysis of fat, protein, somatic cell count, MUN, lactose and total solids. Milk production at d 64 and d 110 did not differ ($P \geq 0.75$) between treatments. MUN on d 68 and d 116 were increased in cows fed DDGS ($P < 0.01$), and both fat and protein were decreased ($P < 0.01$) in milk from DDGS fed cows on d 68. Calf ADG differed ($P < 0.01$) throughout the study, resulting in heavier calf BW from DDGS cows by d 129 ($P < 0.01$, 205 vs. 190 kg). Although calf post-trial ADG did not differ ($P > 0.90$) between treatments, the weight advantage for DDGS fed steers was maintained through weaning at d 219 ($P < 0.01$; 278 vs. 264 kg). Overall pregnancy rates did not differ ($P > 0.64$) between treatments, but timed artificial insemination (TAI) rates were higher for cows fed DDGS ($P < 0.02$). In summary, feeding DDGS to lactating beef cows did not change BW or BCS, but did improve TAI rates and alter milk composition. As a result, cows bred back sooner and male progeny from cows fed DDGS had a higher ADG which resulted in heavier BW at both termination of the study and at weaning. Feeding DDGS to cows during early lactation could be used as a method to program the neonate for improved long-term growth.

Key Words: beef cattle, maternal, milk, developmental programming

107 Metabolism of finishing diets containing condensed distillers solubles and wet distillers grains plus solubles. A. C. Pesta*, A. L. Shreck, T. J. Klopfenstein, and G. E. Erickson, *University of Nebraska, Lincoln.*

Five ruminally cannulated steers (440 ± 37 kg initial BW) were utilized in a 5 × 5 Latin Square designed, 90 d metabolism study. Diets consisted of a dry-rolled and high moisture corn-based control (CON), a 20% wet distillers grains plus solubles (WDGS) diet (20WDGS), a 27% condensed distillers solubles (CDS) diet (27CDS), and 2 diets with 20% WDGS plus either 8.5% CDS (LoMix) or 17% CDS (HiMix). All diets contained 7.5% alfalfa hay and 5% supplement. The 27CDS and HiMix diets were similar in dietary fat (7.5 and 7.6% fat, respectively), thus providing the same amount of fat from either CDS, or a blend of CDS and WDGS. Period length was 18 d and consisted of 13 d of adaptation and 5 d fecal collection. Chromic oxide was dosed intraruminally on d 10 to d 17 as a marker for DM digestibility determination. Rumen fluid was collected on d 18 at 0, 3, 6, 9, 12, and 15 h post-feeding, frozen, and analyzed for VFA profile. Ruminal pH was measured continuously via wireless, submersible probes. Intake of NDF was greatest for steers fed diets containing WDGS ($P < 0.05$), and fat intake was greater for steers fed by-products than for those fed CON ($P > 0.05$). Treatment had no effect on DM, OM, NDF, or fat digestibility ($P > 0.10$). Ruminal acetate concentration was greatest for steers fed CON, 20WDGS, and LoMix diets and lowest for those fed 27CDS, with HiMix being intermediate ($P < 0.10$). Propionate concentration was numerically greatest and acetate:propionate ratio (A:P) was numerically lowest for steers fed 27CDS and HiMix diets ($P > 0.10$). Average ruminal pH was highest for cattle fed 20WDGS, lowest for CON, and intermediate for those fed 27CDS and diets containing both CDS and WDGS ($P < 0.04$). Steers fed CON and 27CDS diets spent more time with pH below 5.6 than those fed diets containing WDGS ($P < 0.05$). Feeding a blend of 20% WDGS and up to 17% CDS, or 27% CDS alone had no impact on diet digestibility and combining these by-products provides another strategy to replace corn in finishing diets.

Key Words: digestibility, distillers solubles, feedlot cattle

108 Feeding condensed distillers solubles in finishing diets containing modified distillers grains plus solubles or Synergy. A. C. Pesta*, B. L. Nuttelman, W. A. Griffin, T. J. Klopfenstein, and G. E. Erickson, *University of Nebraska, Lincoln.*

Four hundred steer calves (339 ± 15 kg initial BW) were utilized in a randomized complete block design experiment to evaluate the effects of adding condensed distillers solubles (CDS) to finishing diets containing either modified distillers grains plus solubles (MDGS) or Synergy (a blend of wet corn gluten feed and MDGS). Steers were blocked by BW, stratified by BW within block, and assigned randomly to pen. Pens were assigned randomly to treatment within block with 5 pens/treatment and 10 steers/pen. Steers were fed for 180 d. A 2 × 4 factorial arrangement of treatments was used, with one factor being level of CDS (0, 7, 14, or 21% diet DM), and the other being by-product type (20% MDGS or Synergy) in the base diet. All diets were based on a 1:1 ratio of dry-rolled and high-moisture corn and contained 6% straw and 5% supplement (DM basis). The CDS used were: 35% DM, 24.4% CP, 18.5% ether extract, and 0.97% sulfur. Dietary fat increased from 5.2 to 8.2% in MDGS-based diets, and from 4.7 to 7.7% in Synergy-based diets, as CDS increased from 0 to 21%, respectively. A by-product × CDS interaction was observed for ADG and HCW ($P < 0.10$). Gain increased linearly ($P = 0.01$) and tended to increase quadratically ($P = 0.09$) in MDGS diets, with calculated maximum ADG occurring at 16% CDS inclusion. Level of CDS had no effect on ADG in Synergy diets. A cubic effect of CDS level was observed for DMI ($P = 0.01$). Dry matter intake was greatest at 14% CDS and lowest at 21% CDS in MDGS diets. Cattle fed Synergy ate 1.9% more DM than those fed MDGS ($P = 0.05$). Feed efficiency (G:F) increased linearly as level of CDS increased, regardless of by-product type ($P < 0.01$). No differences ($P > 0.12$) due to by-product type or CDS level were observed for LM area, 12th rib fat thickness, marbling score, or calculated yield grade. Adding up to 21% CDS to Synergy diets improves performance while replacing corn, however the optimum level of CDS is slightly lower in MDGS diets.

Key Words: by-products, distillers solubles, feedlot

109 Replacing steam-flaked corn or dry rolled corn with condensed distillers solubles in feedlot finishing diets. A. H. Titlow*[1],

S. A. Furman[2], M. K. Luebbe[2], K. H. Jenkins[2], A. L. Shreck[1], and G. E. Erickson[1], *[1]University of Nebraska-Lincoln, Lincoln, [2]University of Nebraska Panhandle Research and Extension Center, Scottsbluff.*

A finishing experiment was conducted to evaluate the effects of corn processing method and level of condensed distillers solubles (CDS). Six treatments were evaluated in a 2 × 3 factorial arrangement as a randomized complete block design with 42 pens of crossbred steers (initial BW = 395 ± 16 kg). Main effects included level of CDS (0, 15, or 30%; DM basis) replacing either dry rolled corn (DRC) or steam-flaked corn (SFC). All diets contained 7% corn silage, 3.5% alfalfa hay, and 4% supplement. Soybean meal and urea were added to meet MP requirements for all diets. Contrasts of level of CDS within DRC or SFC were analyzed for linear and quadratic effects. Interactions ($P < 0.01$) between corn processing method and CDS were observed for carcass-adjusted final BW, ADG, G:F, and HCW. For SFC, final BW, ADG, G:F, and HCW increased linearly ($P < 0.01$). In DRC based diets, increasing level of CDS resulted in a quadratic response ($P < 0.01$) for final BW, ADG, G:F, and HCW. Increasing the level of CDS increased ($P < 0.01$) G:F relative to the control diet for both processing methods. Increasing level of CDS decreased DMI quadratically ($P < 0.01$) for both processing methods. No interactions ($P \geq 0.16$) were observed for LM area, marbling score, quality grade, calculated yield grade, and liver score. These results suggest feeding increasing levels of CDS with either SFC or DRC improves G:F; however, corn processing method influences response.

Table 1. Effects of condensed distillers solubles (CDS) level in dry rolled corn diets (DRC) and steam-flaked corn diets (SFC)

	CDS Level, %DM			*P*-value	
Item	0%	15%	30%	Linear	Quadratic
DRC					
DMI, kg/d	12.1	11.8	10.5	<0.01	<0.01
ADG[1], kg	1.75	1.93	1.80	0.27	<0.01
G:F[1]	0.143	0.164	0.171	<0.01	0.04
SFC					
DMI, kg/d	11.8	11.4	10.7	<0.01	0.04
ADG[1], kg	1.89	1.94	2.00	<0.01	0.89
G:F[1]	0.159	0.167	0.187	<0.01	0.07

[1]Corn processing method × CDS level interaction ($P < 0.05$).

Key Words: condensed distillers solubles, corn processing method, finishing steers

110 Effects of protein and fat concentration in co-product based growing diets on performance and carcass composition. J. R. Segers*, D. W. Shike, D. B. Faulkner, and K. M. Retallick, *University of Illinois, Urbana.*

Angus and Sim-Angus heifers (n = 150) and steers (n = 100) were utilized to evaluate 1 of 5 growing diets in a 2 × 2+1 factorial design: 1) corn-based control (CNT) with 16.7% CP, 3.3% fat; 2) isonitrogenous, isofat co-product blend (ISO) with 16.7% CP, 3.3% fat; 3) high fat co-product blend (HF) with 16.7% CP, 5.1% fat; 4) high protein co-product blend (HP) with 20% CP, 3.3% fat; 5) high fat, high protein co-product blend (HFP) with 20% CP, 5.1% fat. Calves were weaned at 90 d, blocked by sex and then by weight into 25 pens (10 hd/pen). The objective of this experiment was to determine if differing concentrations of protein or fat in co-product-based, growing diets impact feedlot performance or compositional development. Calves were fed experimental diets for 112 d and then acclimated to a common feedlot diet for an additional 112 d. Body weight, hip height (HH), and compositional ultrasound data were collected at 56 d intervals throughout both feeding phases. Collected carcass data included HCW, LM area (LMA), fat thickness at the 12th rib (FT), marbling score (MARB), KPH, and USDA yield grade (YG) and quality grade (QG). There were no interactions ($P > 0.05$) of fat and protein level; therefore, main effects will be discussed. No differences ($P < 0.05$) were detected for BW, ADG, or HH. Although, compositional ultrasound revealed no differences ($P < 0.05$) in FT, increased dietary protein concentrations decreased ($P = 0.02$) ultrasound MARB at d 112, the final day of the growing phase. Also, carcasses from cattle fed high fat diets had greater ($P = 0.02$) MARB compared with those from cattle fed moderate levels of dietary fat. No differences ($P > 0.05$) were observed for HCW, LMA, FT, KPH, or YG. Cattle fed high protein diets produced fewer ($P < 0.01$) carcasses that graded USDA Prime than cattle fed moderate levels of protein. These data indicate that performance was unaffected by protein and fat concentration in growing calf diets, but MARB and QG was influenced by early calf nutrition.

Key Words: co-product, beef cattle, marbling, calf feeding

111 Effects of spoilage of wet distillers grains plus solubles on performance of growing steers. J. L. Harding*, C. J. Schneider, B. L. Nuttelman, T. J. Klopfenstein, and G. E. Erickson, *University of Nebraska, Lincoln.*

A study was conducted using 60 individually fed steers (332 ± 30 kg) fed 4 treatments designed as a 2x2 factorial in a growing study. Treatments were bunkered (spoiled) WDGS vs. bagged (non-spoiled) WDGS fed at 15 or 40% of diet DM. Diets containing 15% WDGS also had 81% grass hay, while diets with 40% WDGS had 57% grass hay. The WDGS was purchased from the same ethanol plant on the same day and split equally within semi-load into either an uncovered bunker or into a silo bag and stored anaerobically for 5 mo (during winter) before the initiation of the experiment. To ensure representative samples of both types, WDGS were collected daily after allowing the WDGS to mix alone in the feed truck before diet mixing. Samples were composited by 35 d periods for nutrient analysis. Composition of non-spoiled WDGS was 35.1% DM, 5.2% ash, 11.2% fat, 34.9% NDF, 33.1% CP, and a pH of 4.0. Composition of spoiled WDGS was 37.0% DM, 5.8% ash, 12.8% fat, 35.1% NDF, 35.2% CP, and a pH of 4.8. Nutrient analyses on the non-spoiled and spoiled WDGS samples were used to calculate nutrient loss for the spoiled WDGS which suggest 6.0% of DM was lost during storage of spoiled WDGS. No mycotoxins were present in either type of WDGS suggesting spoilage is not a concern. There were no level by storage interactions ($P = 0.94$). The steers fed 40% WDGS had greater DMI, ADG, and G:F ($P < 0.01$) compared with steers fed 15% WDGS. Feeding spoiled WDGS decreased DMI ($P < 0.01$) across both levels of dietary WDGS compared with non-spoiled WDGS (8.68 ± 0.69 kg/d for 40% non-spoiled vs. 7.98 ± 0.93 kg/d for 40% spoiled; 7.49 ± 0.73 kg/d for 15% non-spoiled vs. 6.82 ± 1.08 kg/d for 15% spoiled).The diets containing spoiled WDGS had statistically similar ADG (0.57 ± 0.06 kg/d for 40% non-spoiled vs. 0.55 ± 0.09 kg/d for 40% spoiled; 0.34 ± 0.08 kg/d for 15% non-spoiled vs. 0.30 ± 0.09 kg/d for 15% spoiled) and G:F compared with diets with non-spoiled WDGS. Therefore, there were no overall effects of spoilage on ADG, or G:F. However, spoiled WDGS did reduce intakes.

Key Words: storage, spoilage, wet distillers grains plus solubles, cattle

112 Evaluation of a dried distillers grains with solubles cube using field peas as a binder. A. H. Titlow*, J. A. Hansen, M. K. Luebbe, and K. H. Jenkins, *University of Nebraska Panhandle Research and Extension Center, Scottsbluff.*

The objective of this experiment was to evaluate field peas as a binder for dried distillers grains with solubles (DDGS) cubes on cattle ADG. Our hypothesis was that cattle supplemented a cube containing DDGS and field peas would have greater ADG compared with DDGS in a meal form on the ground. Cattle grazing crested wheatgrass pastures were supplemented with, 1) DDGS offered in a meal form on the ground (GROUND), 2) DDGS offered in a meal form in a bunk (BUNK), or 3) 75% DDGS and 25% field pea cube (CUBE) offered on the ground. In year one, 108 crossbred heifers (initial BW = 338 ± 24 kg) and in year 2, 90 crossbred steers (initial BW = 322 ± 10 kg) were utilized. Animals were stratified by BW and assigned randomly to one of 9 pastures. Pastures were then randomly assigned treatments with 3 replications per treatment each year. Cattle were rotated throughout all 9 pastures to prevent a response in performance due to forage quality and quantity within a pasture. The DDGS in both years contained 30.7% crude protein (DM basis). The DDGS and pea cube contained 20.6% CP in year one and 27.1% CP in year 2 (DM basis). Supplementation was targeted to be 0.27 kg of CP daily per animal across all treatments. Data were analyzed using the mixed procedure of SAS and year was considered a random effect. Initial BW was not different ($P = 0.59$) among treatments. Final BW, was lower ($P < 0.01$) for cattle supplemented GROUND compared with BUNK and CUBE (400, 410, and 409 kg, respectively). Cattle supplemented BUNK and CUBE had greater ADG ($P < 0.01$) compared with GROUND (0.70 and 0.71, and 0.61 kg/d, respectively). Based upon the ADG response to type and form of supplementation, field peas are an acceptable binder for DDGS cubes and provide similar performance to feeding DDGS in a bunk.

Key Words: supplementation, DDGS, field peas

113 Effect of urea inclusion in diets containing distillers grains on feedlot cattle performance and carcass characteristics. I. Ceconi*, A. DiCostanzo, and G. I. Crawford, *University of Minnesota, St. Paul.*

Distillers grains (DG) have become a common feedstuff in many feedlot diets. Though DG have a high CP content, a high proportion of this CP is undegradable in the rumen. Therefore, there may be potential performance advantages with addition of degradable intake protein (DIP) to feedlot rations containing DG. An experiment was conducted to evaluate the effect of increasing DIP concentrations in finishing diets on feedlot cattle performance and carcass characteristics. Forty-two Angus and Angus-crossbred steers (427 ± 5 kg initial BW) were assigned randomly to one of 3 dietary treatments (DM basis): 0% (CON), 0.4% (LU), and 0.6% (HU) urea inclusion. The 3 treatments contained (DM basis): 52% dry-rolled corn, 12% high-moisture corn, 20% dried DG, 10% grass hay, and 6% dry supplement. All diets contained 1.32 Mcal NEg/kg and 0.22% S (DM basis). Dietary CP concentrations measured 13.4, 14.5, and 15.1% for CON, LU, and HU, respectively. Steers were fed ad libitum once daily at 0800 using a Calan gate individual feeding system. On d 85, steers were harvested at a commercial abattoir and carcass characteristics were collected. Carcass-adjusted final BW and DMI were similar among treatments ($P \geq 0.58$) and averaged 600, 594, and 613 ± 20 kg and 12.6, 12.6, and 12.9 ± 0.8 kg for CON, LU, and HU, respectively. Carcass-adjusted ADG was higher ($P \leq 0.05$) for HU (2.12 ± 0.07 kg) compared with LU (1.87 ± 0.07 kg) and CON (1.91 ± 0.07 kg) and was similar ($P = 0.73$) between LU and CON. Carcass-adjusted G:F was higher ($P = 0.03$) for HU (0.167 ± 0.008) compared with LU (0.151 ± 0.008), tended ($P = 0.09$) to be higher compared with CON (0.154 ± 0.008) and was similar ($P = 0.61$) between LU and CON. Hot carcass weight, 12th rib backfat, LM area, marbling score, yield grade, and quality grade were similar ($P \geq 0.34$) among treatments. Increasing DIP through inclusion of 0.6% urea in finishing diets containing 20% DG resulted in improvements in ADG and G:F, without affecting carcass characteristics.

Key Words: dried distillers grains, urea, beef cattle

114 Effects of dietary inclusion of manganese oxide in beef cattle feedlot diets containing high dietary concentrations of sulfur. G. I. Crawford*, J. M. Kelzer, J. P. Jaderborg, and A. DiCostanzo, *University of Minnesota, St. Paul.*

A feedlot experiment with 182 cattle (107 crossbred heifers and 75 crossbred steers, initial BW = 331 ± 28 kg) was conducted to determine the effect of supplementing manganese oxide (MnO) to diets containing 0.35 (LS) or 0.60% (HS) dietary S. Four treatments were arranged in a 2 × 2 factorial with factors consisting of dietary S concentration and dietary MnO inclusion of 0 (No Mn) or 1,000 ppm (Mn). The basal diet contained (DM basis) 44% high moisture corn, 35% wet distillers grains, 9% corn silage, 3% wheat straw, and 9% supplement. High S concentrations were achieved with gypsum inclusion in the HS supplement; limestone was added to LS supplement to balance Ca. Cattle were blocked by weight within sex and assigned randomly to 1 of 16 pens, allowing for 4 replications per treatment. Cattle were weighed every 28 d throughout the experiment. The heavy block was harvested after 173 d, and the light block was harvested after 201 d. Through 28 d, the HS, No Mn treatment had lower ($P \leq 0.05$) G:F (0.146) than any other treatment (0.187 across treatments). No other interactions were present ($P \geq 0.15$) at 28 d or for any other live performance measurement. Through 28 d, ADG tended ($P = 0.09$) to be greater with Mn (1.56 kg) compared with no Mn (1.38 kg). Dietary MnO did not affect ($P \geq 0.15$) any other interim or final performance measurement or carcass characteristic. Final BW measured 611 and 558 kg for LS and HS, respectively ($P \leq 0.01$). Cattle consuming the LS treatment had 19% greater DMI/d ($P \leq 0.01$), 25% greater ADG ($P \leq 0.01$), and 6% greater G:F ($P = 0.02$) than HS cattle. A S × MnO interaction ($P = 0.01$) was present for frequency of Prime + Choice carcasses, with the HS, No Mn treatment having 72.1% Prime + Choice carcasses, which was lower ($P \leq 0.05$) than any other treatment (86.4% across treatments). Dietary inclusion of MnO was effective during the first 28 d of feeding high S diets, but had no effect beyond 28 d. High dietary S concentrations had a major effect on live performance and carcass characteristics throughout the experiment.

Key Words: cattle, sulfur, manganese oxide, distillers grains

115 Effects of dietary sulfur on ruminal hydrogen sulfide concentrations over time. S. C. Loerch*[1], F. L. Fluharty[1], L. A. Morrow[1], S. A. Metzger[1], and T. L. Felix[2], *[1]The Ohio State University, Wooster, [2]University of Illinois, Urbana.*

Sulfate reducing bacteria (SRB) generate hydrogen sulfide gas (H_2S) in the rumen from dietary S. Elevated concentrations of H_2S in the rumen increase the incidence of S-induced polioencephalomalacia. Recent research suggests SRB may require time to adapt to dietary S, and this may be important when transitioning cattle to distillers grains-

based finishing diets that exceed the maximum tolerable level for S. However, data regarding SRB response to abrupt exposure of dietary S are lacking. Therefore, the objective of this research was to determine the rumen H_2S concentrations over a 29 d period in response to 3 concentrations of dietary S. Hampshire × Dorsett ewe lambs (54 hd; BW = 33.6 ± 0.4 kg) were blocked by BW and allotted to 3 treatments within each block (6 pens/block, 3 lambs/pen, 18 pens total). Dietary treatments were: 1) 0% added dietary S (NoS), 2) 0.2% added dietary S (LoS), and 3) 0.4% added dietary S (HiS). Sulfur was added to the diet as sodium sulfate, a readily available source of S in the rumen, and the NoS diet contained 0.11% S on a DMB. All lambs were fed the NoS diet for 8 wk before the experiment. On d 1 of the experiment, an abrupt switch to the treatment diets was used. Ruminal gas samples were collected by rumenocentesis at 4 h after feeding on d 1, 8, 15, 22, and 29 to measure H_2S. Sulfur toxicity was not evident. Lambs fed the LoS and HiS diets had greater ($P < 0.01$) ADG and improved ($P < 0.01$) G:F compared those fed the NoS diet; however, S deficiency of lambs fed NoS seems unlikely. Hydrogen sulfide was not detected in lambs fed NoS at any sampling time. Hydrogen sulfide concentrations were less than 50 mg/L on d 1 and 625 mg/L on d 8 and were not affected ($P > 0.19$) by diet. Hydrogen sulfide concentrations were greater ($P < 0.01$) for LoS and HiS than for NoS on d 15, 22, and 29 (LoS was 931, 846, and 1131; HiS was 975, 737, and 1495 mg H_2S/L, on d 15, 22, and 29 respectively). On d 29, 83% of lambs fed LoS or HiS had detectable H_2S. These data suggest it takes at least 29 d for SRB to achieve peak H_2S production after abrupt exposure to diets containing a readily available source of S.

Key Words: hydrogen sulfide, ruminant, bacterial adaptation

116 Effects of supplemental manganese oxide on ruminal hydrogen sulfide concentration, ruminal pH, and feedlot performance of beef cattle fed high-sulfur finishing diets. J. M. Kelzer*[1], M. Ruiz-Moreno[1], G. I. Crawford[1], A. DiCostanzo[1], and G. C. Lamb[2], *[1]University of Minnesota, St. Paul, [2]North Florida Research and Education Center, University of Florida Extension Regional Center, Marianna.*

Excessive ruminal hydrogen sulfide (H_2S) gas in cattle consuming high-S diets reduces feedlot performance and may initiate polioencephalomalacia. Three experiments evaluated the effect of manganese oxide (to oxidize S to SO_4) on ruminal H_2S concentration, pH, and performance of feedlot cattle consuming high-S diets. Experiment 1 evaluated effects of 6 concentrations (DM-basis; 0, 500, 1000, 1500, 2000, 2500 ppm) of Mn as MnO on in vitro gas and H_2S release from substrate containing 0.65% S. At 24-h post-inoculation, 1,000 ppm Mn released less ($P = 0.03$) total H_2S than 0, 500, and 2,500 ppm Mn but released similar ($P \geq 0.19$) H_2S as 1,500 and 2,000 ppm Mn. Concentrations between 1,000 and 2,000 ppm Mn demonstrated potential to reduce 24-h H_2S release from high-S substrate. Experiment 2 evaluated effects of 1,000 ppm Mn as MnO in high-S finishing diets on ruminal pH and H_2S concentration in cannulated steers (n = 7, 437 ± 61 kg BW). Treatments were a base finishing diet (0.46% S) containing 0 (CON) or 1,000 ppm Mn (MNO). Daily DMI was similar ($P = 0.22$) across treatments, but ruminal H_2S concentration tended to be lower ($P = 0.09$) in steers consuming MNO. Ruminal pH was higher ($P = 0.02$) at 1 h before feeding (6.29 for MNO vs. 6.01 for CON); thus, the ruminal environment before feeding may be less conducive to H_2S accumulation in steers fed 1,000 ppm Mn. Experiment 3 evaluated effects of 0 or 1,000 ppm Mn as MnO in finishing diets containing 0.35 (LS) or 0.60% (HS) dietary S on feedlot performance of beef cattle (n = 182, 331 ± 28 kg BW). At d 28, G:F was lower ($P < 0.05$) in cattle fed the HS with 0 ppm Mn diet compared with other diets, and ADG tended ($P = 0.09$) to be greater with 1,000 ppm Mn compared with 0 ppm Mn. Overall, cattle fed LS had 19% greater DMI ($P < 0.01$), 25% greater ADG ($P < 0.01$), and 6% greater G:F ($P = 0.02$). Results confirm high dietary S concentration reduces feedlot performance. Supplemental MnO may mitigate reduced performance during the initial 28 d of high dietary S intake; however, the effect was insignificant beyond 28 d.

Key Words: feedlot cattle, hydrogen sulfide, manganese oxide

117 Interaction of dietary roughage and sulfur concentration on performance of beef feedlot cattle. G. M. Huber*, A. DiCostanzo, and G. I. Crawford, *University of Minnesota, St. Paul.*

An experiment was conducted to determine the effect of differing dietary concentrations of roughage (R) and sulfur (S) in beef cattle feedlot diets. Eighty-four Angus, Limousin, and Charolais steers (initial BW 461 ± 36 kg) were arranged in a randomized complete block design. Steers were fed in a Calan gate individual feeding system and treatments were arranged in a 2 × 3 factorial, with 2 dietary concentrations of S (0.28%, LS or 0.56%, HS) and 3 dietary concentrations of R (5%, LR; 10%, MR; 15%, HR). Steers were harvested after 134 d (block 1 and 2) and 92 d (block 3). Final carcass-adjusted BW was not affected by R, S, or their interaction ($P \geq 0.44$), and averaged 641 kg across treatments. Dry matter intake increased linearly ($P = 0.01$) with increasing R, and averaged 9.9, 10.5, and 10.7 kg/d for LR, MR, and HR, respectively. Increased dietary S concentration decreased ($P = 0.02$) DMI, averaging 10.6 and 10.1 kg/d for LS and HS, respectively. Average daily gain was not affected ($P \geq 0.24$) by R, S, or their interaction, and averaged 1.48 kg across treatments. Gain:feed was not affected by dietary S concentration or a S x R interaction ($P \geq 0.31$) and decreased linearly ($P = 0.01$) with increasing R, averaging 0.151, 0.144, and 0.133 for LR, MR, and HR, respectively. Hot carcass weight (413 kg across treatments), LM area (100 cm^2), 12th rib fat thickness (1.17 cm), marbling score (459), and frequency of individual USDA quality grades were not affected by S, R, or their interaction ($P \geq 0.14$). A tendency ($P = 0.07$) for a decrease in USDA yield grade 1 and 2 carcasses was observed with increasing R and averaged 60.8, 50.1, and 43.0% for LR, MR, and HR, respectively. No other effects on individual USDA yield grades were observed ($P \geq 0.12$). Results suggest that increasing dietary roughage concentration increases DMI while high dietary S concentrations decrease DMI. However, no interactions occurred to suggest that performance may be enhanced by feeding increased roughage in high-S feedlot diets.

Key Words: feedlot cattle, sulfur, distillers grains, roughage

118 Use of crude glycerin in steam-flaked corn-based growing diets. R. G. Bondurant*[1,2], M. K. Luebbe[1], K. Hales[3], N. A. Cole[3], and J. C. MacDonald[1,2], *[1]Texas AgriLife Research, Amarillo, [2]West Texas A&M University, Canyon, [3]USDA-ARS, Bushland, TX.*

Three Exp. were conducted to evaluate the use of crude glycerin in steam-flaked corn (SFC) based growing diets. Experiment 1 utilized 50 crossbred steers (initial BW = 282 ± 2 kg) to determine the effects glycerin concentration (0.0, 2.5, 5.0, 7.5, and 10.0% DM inclusion) on steer performance. As crude glycerin concentration increased, SFC was replaced by crude glycerin while cottonseed meal was increased to maintain an equivalent CP level throughout dietary treatments. In Exp. 2, 54 crossbred steers (initial BW = 283 ± 1 kg) were used to determine the effects of replacing SFC or alfalfa hay (ALF) with crude glycerin

on animal performance. Dietary treatments consisted of 0.0% crude glycerin or 7.5% crude glycerin (CON) which replaced either ALF (REPALF) or SFC (REPSFC). In Exp. 3, in vitro VFA concentration was determined after 48-h of fermentation comparing crude glycerin, SFC, and ALF as substrates. In Exp. 1, increasing dietary crude glycerin concentration resulted in a linear decrease in G:F ($P = 0.05$). Steer ADG and final BW tended ($P = 0.08$) to increase in a quadratic manner with 7.5% crude glycerin resulting in the greatest responses among treatments. No difference was found for final BW and DMI ($P > 0.11$). In Exp. 2, final BW increased 12 kg ($P = 0.04$) for steers fed REPALF vs. CON. Steers fed REPALF also had an increase in ADG of 0.17 kg/day ($P = 0.03$) vs. CON. Final BW and ADG were similar for CON and REPSFC ($P > 0.51$). No differences in DMI or G:F were found among treatments ($P > 0.25$). In Exp. 3, using glycerin as a fermentation substrate resulted in an 83% increase in total VFA concentration compared with ALF ($P < 0.01$), and similar total VFA concentration compared with SFC ($P = 0.42$). The acetate to propionate ratio was reduced 12-fold for glycerin vs. SFC ($P < 0.01$), and reduced 25-fold for glycerin vs. ALF ($P < 0.01$). Crude glycerin appears to have a minimal impact on animal performance when replacing SFC, although G:F may be reduced by up to 4.5% when including glycerin at 7.5% of the diet DM, where ADG appears to be maximized. The energy value of crude glycerin is greater than ALF but appears to be less than SFC.

Key Words: crude glycerin, growing, beef cattle

119 Evaluation of advising procedures for animal science majors at Purdue University. M. A. Diekman*, *Purdue University, West Lafayette, IN.*

Currently the Department of Animal Sciences at Purdue University has 675 students working toward a B.S. degree in one of 6 concentrations: pre-veterinary medicine (n = 498, 73.8%), agribusiness (n = 70, 10.4%), behavior/well-being (n = 54, 8.0%), production (n = 27, 4.0%), biosciences (n = 22, 3.2%) and products (n = 4, 0.6%). Eighteen of 29 faculty members (62.1%) are primary advisors: one professional specialist (33 advisees, 4.9%), 2 assistant professors (51 advisees, 7.6%), 7 associate professors (264 advisees, 39.1%) and 8 full professors (327 advisees, 48.4%). Eight of the 18 advisors have a majority research appointment (44.4%), 6 have a majority extension appointment (33.3%) and 4 have a majority teaching appointment (22.2%). Within the next 3 to 5 years, approximately 50% of the advising power in the department may be retired with very little interest shown by assistant professors to become advisors. Summary of SWOT analyses from 41 of 80 students (51.2%) that graduated in May 2010 revealed that accessibility and knowledge of the curriculum were the major attributes that a good advisor needs to possess. The role of the professor being the main contact with prospective employers has shifted to employment agencies or students contact companies electronically or via job fairs. Overall, students now desire to investigate career options through other means rather than a face-to-face discussion with their advisor. In general, pre-veterinary students delay making alternate career plans until veterinary school is no longer an option. A major complaint was that the area of expertise of the advisor did not match the career goal of the advisee, species interest or method of communication especially students interested in companion, zoo or exotic animals. Attempts to improve advising/advisee relationships in animal sciences may involve hiring professional assistants in advising, continued movement of registration procedures and audit capability online and establish a reward system to recognize excellence in advising undergraduate students.

Key Words: advising, undergraduates, animal sciences

120 Using a hybrid course structure to enhance student engagement and learning of swine management and production. B. D. Whitaker*, *University of Findlay, Findlay, OH.*

Students often have little knowledge or experience of the swine industry. To introduce students to the dynamics and principles behind the swine industry and pork production, the swine production and management course was developed and taught in a hybrid style. This strategy incorporated lecture, practical experiences, and small group projects into each session. The course goals were to: 1) explain key concepts in today's industry; 2) demonstrate comprehension by solving issues associated with the industry, and 3) create a swine production system which would be accepted by current industry standards. Activities were designed to provide a mechanism for students to integrate classroom discussion into experiential situations. Students (n = 48) were evaluated through pre- and post-course assessments to determine if the hybrid classroom structure increased their understanding and application of knowledge, based on a scale where 1 = not at all and 10 = expert level. Criteria for increasing knowledge was a positive change in individual assessment score, successfully applying knowledge was defined as 90% of the groups receiving a grade of >80% on an assignment, and a successful educational experience was defined as the students rating the experience >7. All students significantly increased ($P < 0.05$) their knowledge of swine production and management based on post-assessment compared with pre-assessment scores. Project scores indicated significant numbers ($P < 0.05$) of students were successful in applying knowledge. Students agreed that projects were important (7.26) and increased their comprehension of the material (7.91). Students believe that the course objectives were met (8.09) but did not fully support the use of group learning environments (6.85). The hybrid strategy was a success (8.54), as it provided opportunities for practical experiences (8.89), which are continuously requested by students (9.11). Based on these results, a hybrid course strategy will continue to be implemented with modifications to encourage better group dynamics to cultivate students' interest in swine production.

Key Words: hybrid learning, swine production, hands-on learning

121 Effect of making an audio recording on writing quality of a student term paper in an introductory animal sciences course. W. R. Lamberson*[2], A. A. Lannin[1], B. Selting[1], C. A. Chmidling[1], T. M. Taxis[2], and S. D. McKay[2], *[1]Campus Writing Program, University of Missouri, Columbia, [2]Division of Animal Sciences, University of Missouri, Columbia.*

Animal Sciences 1011 is a course in which introductions to the disciplines of the animal sciences are taught as discrete units. Students are mostly freshman animal science majors, but also include other majors and upper classmen. To help tie the units together in a cohesive whole, students are required to submit a term paper in which each identifies a specific animal of a livestock species, perhaps a steer they have shown in 4–H, and relates the material from the course to the life cycle of their animal. In 2010, students were required to submit a voice email of this term paper 2 d before the written papers were due. The objective of this study was to determine if requiring the audio recording affected the quality of the written papers. Papers from 2009, when the identical assignment except with no audio recording was required, were on file. A professional grader used primary trait analysis to evaluate papers, de identified with respect to student and date, from both groups. Papers were scored 1 to 5 on the following: grammar, word usage, appropriate use of paragraphs, overall flow, general content, and relationship between the material and their animal. Writing scores were fitted to a statistical model including the effects of recording and average exam score for the course and their interaction. Average exam score did not differ between groups. Average exam score had a highly significant positive influence on all scores except for relating material to their animal, for which there was no effect. Students who submitted an audio recording had improved ($P < 0.01$) scores for word usage and content, but, surprisingly, not for grammar, appropriate use of paragraphs, or overall flow. Comparison of the recording to the written papers revealed that the students tended to correct grammar and pace when reading the papers, but did not correct them in the written version. Encouraging students to read a paper aloud during the revision process may result in improved paper quality, but alternatives may be more effective.

Key Words: recording, writing, quality

122 A five year review of the Graduate Experience Program. T. M. Taxis*, E. R. McGill, G. W. Jesse, and W. R. Lamberson, *University of Missouri, Columbia.*

The Graduate Experience Program (GEP) was started in 2007 by the graduate students in the Animal Science Department at the University of Missouri. The class was designed to provide insight into graduate education and career opportunities within animal science. To ensure the undergraduate interests were being met, they were paired with a graduate student mentor with whom they were expected to meet at least once a week outside of the normal weekly class meeting. By pairing undergraduate students with graduate mentors, the founding graduate students also created a 2-fold learning experience. Not only were the undergraduates introduced to first-hand experience with graduate training, but also graduate students, sometimes for the first time, were able to experience a mentoring position. In the classroom, program goals were met by introducing activities in developing career goals, applying to graduate schools, writing resumes, outlining expectations and demands of graduate school, reading scientific articles, and presenting research. In the past 5 years, 40 undergraduate students and more than 30 graduate student mentors have been involved with the class. This year past students and mentors were surveyed on their experience. Mentors and students alike claim they would not be where they are today if it were not for GEP. The students valued the information and relationships gained between them and their mentor and professors. Many students experienced a common theme in the survey saying GEP made it less intimating to walk into a lab and talk to a graduate student or professor. Mentors, like students, have had a positive experience with GEP. The class increased their knowledge or interest in advising undergraduate students. This included things like learning which questions to ask and the importance of keeping the mentorship informal to allow the students to feel comfortable talking. One most rewarding topic shared by the mentors was the personal relationship between them and the student, and to hear how the student is utilizing what they learned from the mentor in GEP in their current position.

Key Words: undergraduate, research, teaching

123 Amino acid composition and digestibility of mold damaged corn selected for low mycotoxin content fed to finishing pigs. C. M. Pilcher*, A. Greco, C. R. Hurburgh, and J. F. Patience, *Iowa State University, Ames.*

There is very limited information on the impact of mold damage on the digestibility of nutrients in corn. The objective of this study was to determine the AA composition and apparent ileal digestibility (AID) of AA in mold damaged corn (MDC) samples selected for low mycotoxin content. Corn samples with visible mold damage were collected from 14 Midwestern sites and corn samples with no visible mold damage were selected from 4 Midwestern sites. All samples were screened for mycotoxin content and 7 MDC samples with low mycotoxin content (i.e., <1 ppm deoxynivalenol; <20 ppb aflatoxin; <10 ppm fumonisin; <3 ppm zearalenone) were utilized and a single control corn (CC) sample was created by blending 3 samples with no visible mold damage. There was variation in test weight (58 to 72 kg/hL; mean = 67 ± 5.2 kg/hL) and total damaged kernels (TDK) (9.4 to 65.8%; mean = 33.8 ± 21.70%) among MDC samples. Total Lys, Thr and Met (DM basis) were lower for CC (0.24, 0.30 and 0.14%) and MDC (range = 0.22 to 0.24, 0.28 to 0.30 and 0.13 to 0.15%) than previously published values for corn. Experimental diets were comprised of 96.9% CC or one of the 7 MDC sources, supplemented with vitamins and minerals. Sixteen barrows (initial BW = 99.0 ± 4.98 kg) surgically fitted with a T-cannula in the distal ileum were allotted to an incomplete crossover design with 8 diets and 3 replicate periods. Periods included 8 d of adaptation to diets followed by 2 d of ileal digesta collection. Within MDC samples, 3 out of 7 had significantly lower AID of Thr than CC (44.8, 46.0 and 46.8 vs. 57.0%; $P < 0.05$), 1 of 7 had significantly lower AID of Met than CC (73.0 vs. 78.5%; $P < 0.05$), 2 of 7 had lower AID of TSAA than CC (64.0 and 64.0 vs. 70.5%; $P < 0.05$) and 2 out of 7 had significantly lower AID of Trp than CC (21.0 and 26.7 vs. 40.6%; $P < 0.01$). There were negative correlations between TDK and AID of Lys, Thr, TSAA and Trp (r = −0.35, −0.42, −0.40 and −0.56, respectively; $P < 0.025$). In conclusion, mold infestation of corn may reduce AID of AA, and TDK was negatively correlated with the AID of several indispensible AA.

Key Words: corn, mold, amino acids, swine

124 Amino acid digestibility and energy concentration in conventional, high protein, and low oligosaccharide varieties of full fat soybeans fed to growing pigs. J. Yoon* and H. H. Stein, *University of Illinois, Urbana.*

Two experiments were conducted to determine AA and energy digestibility in full fat soybeans (FFSB). Conventional (FFSB-CV; 43.5% CP and 24.1% crude fat), high protein (FFSB-HP; 50.2% CP and 20.5% crude fat), and low oligosaccharide (FFSB-LO; 46.8% CP and 21.1% crude fat) varieties of FFSB were used. In Exp. 1, the standardized ileal digestibility (SID) of CP and AA in the 3 ingredients was determined using 8 growing barrows (initial BW: 20.6 ± 1.1 kg) that were equipped with a T-cannula in the distal ileum. All diets contained FFSB as the sole source of AA. An N-free diet was used to determine basal endogenous losses of AA. The pigs were allotted to a replicated 4 × 4 Latin square design with 4 periods and 4 diets. The SID of most AA in FFSB-CV and FFSB-LO is greater ($P < 0.05$) than in FFSB-HP Table 1). In Exp. 2, the DE and ME in the 3 sources of FFSB were determined using 24 growing barrows (initial BW: 28.3 ± 3.7 kg). A corn-based basal diet and 3 diets containing corn and 1 source of FFSB were formulated. Pigs were placed in metabolism cages and randomly allotted to the 4 diets. After a 5 d adaptation period, feces and urine were collected for the next 5 d. The DE and ME in each source of FFSB were calculated using the difference procedure. The concentrations of DE and ME in FFSB-CV, FFSB-HP, and FFSB-LO were 4,495 and 4,192; 4,765 and 4,447; and 4,694 and 4,349 kcal/kg DM, respectively, but no differences among the 3 sources of FFSB were observed. Results indicate that the SID of most AA in FFSB-LO, but not in FFSB-HP, is similar to values in FFSB-CV, but significant differences in DE and ME among the 3 sources of FFSB were not observed.

Table 1. Standardized ileal digestibility of AA

Item	FFSB-CV	FFSB-HP	FFSB-LO	SEM	*P*-value
Ile	84[a]	77[b]	81[ab]	3.6	0.04
Leu	85[a]	78[b]	82[ab]	3.4	0.03
Lys	86[a]	80[b]	84[ab]	3.2	0.04
Met	84	79	83	3.4	0.06
Phe	86[a]	79[b]	82[ab]	3.5	0.04
Thr	83[a]	76[b]	80[a]	3.4	0.01
Trp	85	81	85	2.6	0.09
Val	83[a]	76[b]	79[ab]	3.9	0.04

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

125 Impact of a whole yeast product on sow and litter performance. B. Bass*[1], V. Perez[2], H. Yang[2], D. Holzgraefe[2], J. Chewning[1], and C. Maxwell[1], *[1]University of Arkansas, Fayetteville, [2]ADM Alliance Nutrition, Inc., Quincy, IL.*

A study was conducted using 3 groups of gestating gilts and sows (n = 98) to determine the effects of *Pichia guilliermondii* (Pg), a whole yeast product (CitriStim, ADM Alliance Nutrition) on dam and litter performance. Within 24 h of breeding, gilts and sows were allotted, based on BW and parity, to one of 3 dietary treatments consisting of a corn, soybean meal, and distillers dried grains with solubles (30 and 10% in gestation and lactation, respectively)-based diet alone, or supplemented with either 0.1 or 0.2% Pg in a randomized complete block design. On d 110 of gestation sows were moved to a farrowing facility and provided a lactation diet, maintaining gestation treatment (control, 0.1 or 0.2% Pg). Inclusion of Pg resulted in an increase in number born alive as the level of Pg increased (12.49, 13.33, and 13.43 born alive per litter for control, 0.1 and 0.2% Pg, respectively; linear effect, $P < 0.01$). Additionally, the percentage of piglets weighing less than 0.9 kg at birth was reduced in sows provided Pg at 0.1 or 0.2% compared with controls (linear effect, $P = 0.0057$). Sow receiving Pg during gestation and lactation also weaned a greater number of piglets (10.31, 10.55, and 10.60 weaned per litter in control, 0.1 and 0.2% Pg, respectively; linear effect, $P < 0.01$) than controls. However, percent preweaning mortality was 17.58, 19.38, and 19.61% for control, 0.1 and 0.2% Pg, respectively (linear effect, $P < 0.02$). There were no differences in gestation BW gain, farrowing (d 110 to 48 h post-farrowing) or lactation BW loss (d 110 to weaning), individual birth and weaning weight, or number of mummies or stillborns ($P > 0.05$). In conclusion, inclusion of a whole yeast product in sow diets increased, in a linear fashion, total number born alive and weaned, without a change in average birth or weaning weight, and decreased the number of lightweight pigs at birth.

Key Words: sow, yeast product, litter size

126 Impact of a whole yeast product (*Pichia guilliermondii*; CitriStim) on weaned pig performance. B. Bass*[1], V. Perez[2], H. Yang[2], D. Holzgraefe[2], J. Chewning[1], and C. Maxwell[1], *[1]University of Arkansas, Fayetteville, [2]ADM Alliance Nutrition Inc., Quincy, IL.*

At approximately 21 d of age, 2 trials were conducted using pigs from 2 separate farrowing groups of sows that were fed 1 of 3 dietary treatments (control [corn/SBM/10% distillers dried grains with solubles] alone or supplemented with 0.1 or 0.2% CitriStim [ADM Alliance Nutrition; *Pichia guilliermondii* (Pg), a whole yeast product]). Pigs were individually weighed and allotted to either a control diet, or a diet containing Pg in a 3 × 2 factorial arrangement in a RCBD (n = 336 and 288 pigs in Exp. 1 and 2, respectively). Pigs were provided feed and water ad libitum during phase 1 (P1), phase 2 (P2) and phase 3 (P3) for 7, 14, and 14 d, respectively, in both studies. Pg was included at 0.2, 0.1, and 0.1% in P1, P2, and P3, respectively, in Exp. 1, and 0.2% in all phases in Exp. 2. In Exp. 1, Pg inclusion in sow diets increased P1–2 ADG, and BW (11.45, 12.05, and 12.17 kg for control, 0.1 and 0.2%, respectively) at the end of P2 ($P = 0.02$). Additionally, ADG, ADFI, and BW increased in P1 as level of Pg in sow diet increased in pigs fed Pg in the nursery, with no change in pigs receiving control diets in the nursery regardless of sow treatment (interaction; $P < 0.05$). ADFI increased as level of Pg increased in sow diets in Pg fed weaned pigs in P1–2, P3, and the overall nursery period whereas a decrease was observed as sow level of Pg increased in control fed weaned pigs (interaction; $P < 0.04$). An increase in G:F was observed in P2, P1–2, and the overall nursery period in control fed weaned pigs as level of Pg increased in sow diets, however weaned pigs fed Pg had similar G:F regardless of sow treatment (interaction; $P < 0.03$). In Exp. 2, a linear increase ($P < 0.02$) was observed in ADG, ADFI and G:F for P1, P2, P1–2, and the overall nursery period as the level of Pg fed to sows increased. Additionally, BW at the end of P2 and P3 ($P < 0.01$) increased linearly with increasing Pg in sow diets. No sow × nursery treatment interactions were observed in Exp. 2. In conclusion, inclusion of a whole yeast product in sow and nursery diets improved weaned pig performance, and this improvement may be additive.

Key Words: weaned pig, nursery, yeast product

127 Effects of plant extracts on immune function and disease resistance in pigs. Y. Liu* and J. E. Pettigrew, *University of Illinois, Urbana.*

One in vitro and 2 in vivo studies were conducted to evaluate the effects of plant extracts (PE) on immune function and disease resistance in pigs. The first study evaluated the effects of 7 PE (anethol, capsicum oleoresin, carvacrol, cinnamaldehyde, eugenol, garlicon, and turmeric oleoresin) on tumor necrosis factor (TNF)-α and IL-1β secretion from porcine alveolar macrophages (PAM) with lipopolysaccharide (LPS) stimulation. All PE suppressed ($P < 0.05$, 15 to 100%) TNF-α, and carvacrol, cinnamaldehyde, eugenol, or garlicon decreased ($P < 0.05$, 31 to 95%) IL-1β secretion from LPS-stimulated PAM. This in vitro study indicates all PE may have anti-inflammatory effects to varying degrees. The second study evaluated the effects of 3 PE (capsicum oleoresin, garlicon, and turmeric oleoresin) on diarrhea, immune responses, and intestinal morphology of weaned pigs experimentally infected with a pathogenic F-18 *E. coli*. The *E. coli* infection increased ($P < 0.05$) diarrhea score (DS), frequency of diarrhea, the number of white blood cells (WBC), and serum TNF-α and hapotoglobin (Hp), and reduced overall ADG, G:F, and villi height (VH) of the small intestine. In the *E. coli* challenged group, the supplementation of 10 mg of each 3 PE/kg diet reduced DS from d 0 to 2 and 6 to 11 after challenge and overall frequency of diarrhea, decreased ($P < 0.05$) serum TNF-α and Hp and WBC and the number of neutrophils, and increased ($P < 0.05$) ileal VH, compared with the control diet (CON). The third study evaluated the effects of the same 3 PE on growth efficiency and immune responses of pigs experimentally infected with PRRS virus (PRRSV). The PRRSV infection reduced ($P < 0.01$) growth performance, but increased ($P < 0.05$) rectal temperature (RT), viral load (VL), and PRRSV specific antibody titer (AT), and serum inflammatory mediators. In the PRRSV challenged group, the 3 PE increased ($P < 0.05$) G:F, serum IL-10 and and Hp, and reduced ($P < 0.05$) VL, serum TNF-α and C-reactive protein, and RT compared with the CON. In summary, PE are potent immunomodulators and may enhance the disease resistance in pigs.

Key Words: *Escherichia coli*, immune, plant extracts, porcine reproductive and respiratory syndrome virus

128 Nutritional values of carbohydrate sources fed to pigs. S. K. Cervantes-Pahm* and H. H. Stein, *University of Illinois, Urbana.*

Three experiments were conducted to determine the digestibility of GE and nutrients and the caloric value in carbohydrate sources fed to growing pigs. In Exp. 1, the caloric value of resistant starch (RS 60 and RS 70), soluble corn fiber (SCF), pullulan and maltodextrin were determined. The ME for RS 60 (1,903 kcal/kg), RS 75(1,677 kcal/kg), and SCF (1,712 kcal/kg) were less ($P < 0.05$) than for maltodextrin (3,344 kcal/kg) and pullulan (2,766 kcal/kg), and pullulan contained less ($P < 0.05$) ME than maltodextrin. In Exp. 2, the effect of RS 60, RS 70, SCF, pullulan and cellulose on apparent ileal (AID) and apparent total tract (ATTD) disappearance of GE, CP, and total dietary fiber (TDF) and on standardized ileal (SID) and standardized total tract (STTD) disappearance of TDF were determined. Results indicated that the AID of GE and DM was reduced ($P < 0.05$) by addition of fiber to the diets, but the ATTD of GE and DM was not different among diets. The addition of cellulose and pullulan, but not RS 60, RS 75, and SCF reduced ($P < 0.01$) the AID of CP. The average ileal and total tract endogenous losses of TDF were calculated as 25.25 and 42.87 g/kg DMI, respectively. The SID of TDF in diets containing RS 60, SCF, and pullulan were greater ($P < 0.01$) than the SID of TDF in the cellulose diet, but the STTD of the SCF diet was greater ($P < 0.05$) than for the cellulose and pullulan diets. The caloric value and the AID and ATTD of energy and nutrients in yellow dent corn, Nutridense corn, dehulled barley, dehulled oats, polished rice, rye, sorghum, and wheat fed to growing pigs were determined in Exp. 3. The AID of GE, OM, and total carbohydrates was greater ($P < 0.001$) in rice than in all other cereal grains. Although dehulled oats, Nutridense corn, and wheat contained more TDF, the AID of starch in these grains was not different from rice. Dehulled oats had the greatest ($P < 0.001$) ME (kcal/kg DM) whereas rye had the least ME (kcal/kg DM) among the cereal grains. Results indicated that the caloric value and the AID of starch were not influenced by the concentration of TDF in the cereal grains.

Key Words: carbohydrates, digestibility, total dietary fiber

129 Determination of the effectiveness of a feed grade NSP enzyme (Easyzyme) to improve swine performance in the late-finishing period. L. Greiner[1], D. Holzgraefe[2], V. Perez[2], and J. Hahn*[2], *[1]Innovative Swine Solutions LLC, Carthage, IL, [2]Archer Daniels Midland Inc., Quincy, IL.*

A study was conducted in a commercial research facility to evaluate the effect of Easyzyme, an NSP Enzyme (NSPE), on swine perfor-

mance in late-finishing. A total of 1200 pigs (PIC C29X327) were placed into a wean-to- finish facility at 23 ± 2 d of age. Pigs were placed 25 animals per single sex pen. Pens were blocked into 3 replicate weight groups of gilts and 3 replicate weight groups of barrows. Pen groups of pigs were maintained throughout the study without replacement (44 animals died or were removed before late finishing allotment). All pigs received a common feeding program containing at least 20% corn co-products until the mean weight was approximately 82 kg. The late-finishing study was designed as a 2 × 4 factorial. NSPE inclusion (w/wo 0.05% NSPE) and supplemental dietary fat level (0, 1, 2, and 3%) were the primary factors. At final allotment, pigs were weighed by pen. Within a replicate sex block, pens were randomly assigned to one of the 8 dietary treatments. ADG, ADFI, and G:F were determined for 3 periods, d 0–35, d 36–50, and d 0–50. Pigs were fed Paylean at 4.5 g/ton during the d 36–50 period. Diets included corn, soybean meal, corn distiller's grain with solubles (corn DDGS), and corn germ meal. The data analysis included a model consisting of replication, fat level, NSPE inclusion and all interactions. No interactions between NSPE and supplemental fat inclusion were detected for any period. The inclusion of NSPE resulted in increased d 36–50 ($P = 0.01$) and d 0–50 ($P = 0.07$) ADG, increased ($P < 0.05$) ADFI for all periods, and increased ($P = 0.10$) G:F for the d 36–50 period. The main effect of increasing supplemental fat from 0 to 3% was a trend toward improved G:F ($P = 0.11$) for the d 0–35 period and a significant ($P = 0.07$) increase in G:F in the d 36–50 period. Results of this trial indicate that inclusion of NSPE can have a positive impact on late-finishing swine performance when feeding corn co-products.

Key Words: swine, NSP, enzyme, Easyzyme

130 In vitro fermentation and microscopic matrix of distillers dried grains with solubles following enzyme treatment. R. Jha*[1], J. Li[1], M. R. Bedford[2], C. R. Christensen[3], T. Vasanthan[1], and R. T. Zijlstra[1], *[1]University of Alberta, Edmonton, AB, Canada, [2]AB Vista Feed Ingredients, Wilts, UK, [3]University of Saskatchewan, Saskatoon, SK, Canada.*

Digestibility of distillers dried grains with solubles (DDGS) is lower than of grains. Physico-chemical causes for the lower digestibility of DDGS by porcine enzymes are poorly understood. Thus, DDGS were treated with carbohydrate-degrading enzymes (C) and protease (P) during an in vitro fermentation model of the pig lower intestine. DDGS samples were pre-digested with pepsin and pancreatin to simulate upper gut digestion. Residues were incubated in buffered mineral solution inoculated with pig feces. In a 3 × 3 factorial arrangement, gas production, proportional to amount of fermented carbohydrate, was measured for 72 h for 3 DDGS (2 samples of wheat DDGS, wDDGS1 and wDDGS2; corn DDGS, cDDGS) and 3 enzymatic treatments during fermentation (control, without enzyme; C; C+P). The fermented solution was analyzed for VFA. The matrix of DDGS and residues was analyzed using confocal laser electron microscopy (CLSM) and scanning electron microscopy (SEM). Total gas production was higher ($P < 0.05$) for cDDGS than wDDGS, and was higher ($P < 0.05$) for C than control and C+P. The pattern was similar for total VFA production; but DDGS and enzymes interacted ($P = 0.010$). Total VFA production was highest ($P < 0.05$) for cDDGS either control or C, and lowest for wDDGS1 with C+P (6.5, 6.2, and 4.0 mMol/g, respectively). Using CLSM and SEM, the fiber-starch-protein matrix of wDDGS2 was highly interspersed and less degraded; even after fermentation with C or C+P. Instead, the matrix of cDDGS was loosely imbedded. In conclusion, C unlocked the fiber-starch-protein matrix better for fermentation than C+P, indicating that the substrate for C hinders degradation of the DDGS matrix. Moreover, the matrix of cDDGS is less imbedded than that of wDDGS and is more fermentable than wDDGS. During in vitro fermentation, carbohydrate-degrading enzymes can enhance degradation of DDGS.

Key Words: DDGS, enzyme, pig

131 Effects of spray-dried plasma (SDP), clays, and spray-dried egg (SDE) on productive performance and health of pigs and mice. M. Song* and J. E. Pettigrew, *University of Illinois, Urbana.*

Three sets of experiments were conducted to evaluate whether SDP, clays, and SDE can improve animal productivity and health. Within each experiment, diets were isocaloric and isolysinic. The first set of 2 studies evaluated whether dietary SDP 1) improves pregnancy rate of mated female mice under transport stress as a model for stressed sows, and 2) ameliorates inflammation and impairment of reproduction of pregnant mice after LPS challenge as a model for inflammation in sows. The SDP markedly increased ($P < 0.05$) pregnancy rate (245%) of the mated female mice after transport. The SDP increased ($P < 0.05$) growth of the pregnant mice (12%) and their fetal wt (14%), and reduced ($P < 0.05$) markers of inflammation in both uterus (TNF-α, 45%; IFN-γ, 59%; IL-10, 22%; TGF-β1, 44%) and placenta (TNF-α, 27%; IFN-γ, 59%), but did not affect pregnancy loss or fetal death during inflammation. The second set of 2 studies evaluated whether dietary clays reduce diarrhea of weaned pigs experimentally infected with a pathogenic *E. coli*. In the *E. coli* challenged group, clay treatments (smectite, kaolinite, and zeolite individually and all possible combinations) reduced ($P < 0.05$) overall diarrhea score (12–46%) and ratio of β-hemolytic coliforms to total coliforms (31–66%), and altered ($P < 0.10$) total and differential white blood cells. The third set of 4 studies evaluated whether dietary SDE can improve growth performance or health of weaned pigs. The SDE improved ($P < 0.05$) ADG (13–19%) and ADFI (5–17%) in the first 2 studies (diets with antibiotics and zinc oxide, but no SDP). In the third study (a commercial farm trial; diets with SDP, antibiotics, and zinc oxide), SDE reduced frequency of medical treatments during the first wk after weaning (45%, $P < 0.05$) and the overall 6 wk period (17%; $P = 0.062$), but did not affect growth rate. In the fourth study (diets without antibiotics and zinc oxide), replacement of SDP by SDE did not affect growth rate. In conclusion, SDP, clays, and SDE provide nutrient contribution or physiological benefits that may contribute to animal productivity and health.

Key Words: clays, spray-dried plasma, spray-dried egg

Equine

132 Best management practices on horse farms in Minnesota and Wisconsin. J. E. Earing*, E. M. Allen, C. C. Shaeffer, J. A. Lamb, and K. L. Martinson, *University of Minnesota, St. Paul.*

University of Minnesota Extension specialists regularly receive questions regarding horse pasture management. To meet this need, the Equine Pasture Management Program was developed. In addition to providing management recommendations, this program collected data regarding the use of best management practices (BMP) on horse farms in Minnesota and western Wisconsin. The objective was to determine what BMP were currently being used. Best management practices evaluated at each farm included the use of a sacrifice lot, rotational grazing, soil nutrient management, weed control, and manure storage. Nineteen farms participated in the pasture management program; of these, 16 were used for personal recreation, 2 were therapeutic riding facilities, and one was a boarding facility. Ten of the farms had been purchased within the last 3 years; however, all farm owners had owned horses for a longer period of time. The median farm size was 13 acres, with 7 acres used for horse turn-out. The median number of horses was 4, resulting in a stocking density of 1.75 acres per horse. Sixteen farms had a designated sacrifice lot. Only one farm had soil sampled and fertilized in the last 3 years. Soil analysis from all 19 farms indicated that fertilization for at least one of the 3 primary macronutrients (N, P, K) was necessary. On farms with established pastures, the average ground cover was 88%; the predominant grasses were Kentucky bluegrass and smooth bromegrass. Three farms had used herbicide for weed control in the last 3 years, but none of the farms utilized regular mowing as a weed control strategy. While 6 farms used some form of rotational grazing, all but one exhibited signs of overgrazing. Twelve farms stockpiled their manure, but only one farm was aware of their state or county's manure storage regulations. We suggest that farm owners are aware of some BMPs recommended for horse farms, but practices are not fully or consistently implemented. These observations will be useful in developing educational programming for horse farm owners focusing on the implementation of several horse pasture and grazing BMPs.

Key Words: horse pasture, manure, fertilization, rotational grazing

133 Body condition score of horses at two Minnesota shows. K. Martinson*[1], J. Earing[1], R. Coleman[2], and M. McCue[1], *[1]University of Minnesota, St. Paul, [2]University of Kentucky, Lexington.*

As the incidence of disorders that are worsened by increased body weight become more prevalent in the horse population, horse owners, veterinarians, and professionals often use body condition score (BCS) to monitor and manage a horse′s weight. The objectives were to determine BCS of adult horses at 2 Minnesota horse shows, and to determine if BCS was different between shows and among breeds, ages, genders, and disciplines. In September 2011, BSC of 679 horses was determined; 247 at the Minnesota State 4-H Horse Show, and 432 at the Western Saddle Club Association Champ Show. Body condition was scored on a scale of 1 (poor) to 9 (extremely fat) by 2 trained evaluators. Age, breed, discipline, and gender of each horse were also recorded. After eliminating pregnant mares and horses less than 3 years of age, data on 636 horses were analyzed. Data were analyzed with an ANOVA and multi-variant regression with BCS as the dependent variable and age, breed, discipline, and gender as fixed effects. Top 5 breeds in the sample included Quarter Horses (n = 345), American Paint Horses (n = 109), Arabians (n = 43), Appaloosas (n = 28) and Pony of the Americans (POA; n = 21). Disciplines included driving (n = 5), English (n = 22) and western (n = 81) pleasure, all-around (n = 231), and speed events (n = 297). The majority of horses shown where either geldings (n = 343) or mares (n = 291), and ranged from 3 to 32 years old with a mean of 11.8 years. Body condition scores ranged from 2 to 8, with a mean of 5.6. Body condition score was not different ($P > 0.05$) between shows or among genders and disciplines. Body condition score was different among breeds ($P < 0.001$) and ages ($P = 0.005$). Welsh, POA, pony crosses, and unregistered horses tended to have higher BCS compared with Appaloosas, Quarter Horses, Arabians, and Appendix Quarter Horses. Older horses (>20 years) tended to have lower BCS compared with younger horses. These results validate that pony breeds tend to have higher BCS, while older horses tend to have lower BCS. Owners and professionals should frequently monitor pony breeds and older horses to ensure they are maintaining a moderate BCS.

Key Words: horse, body condition score, breed, age

134 The effect of soaking on protein and mineral loss from orchardgrass and alfalfa hays. K. Martinson*[1], H. Jung[1,2], M. Hathaway[1], and C. Sheaffer[2], *[1]University of Minnesota, St. Paul, [2]USDA-ARS, St. Paul, MN.*

Soaking hay is a common strategy used to manage horses diagnosed with laminitis, polysaccaride storage myopathy, hyperkalemic periodic paralysis, or chronic obstructive pulmonary disease. Although certain nutrients such as nonstructural carbohydrates and potassium are commonly targeted during soaking, other essential nutrients may be inadvertently lost. The objectives of this research were to determine the impact of water temperature and soaking duration on removal of crude protein and macro-minerals from legume and cool-season grass hays. The experimental design was a randomized complete block with 6 replications. Hay types included bud and flowering alfalfa and vegetative and flowering orchardgrass. Flakes were submerged for 15, 30 and 60 min in 25 L of cold (22°C) and warm (39°C) water and 12 h in cold water. Soaking had no effect ($P > 0.05$) on CP concentration of bud-stage alfalfa or flowering orchardgrass hays; however, CP increased ($P = 0.02$) as soaking duration increased in vegetative orchardgrass hay, and decreased as soaking duration increased ($P < 0.001$) in flowering alfalfa hay. Soaking did not affect ($P > 0.05$) Ca concentrations in flowering alfalfa and orchardgrass hays, but resulted in a reduction of Ca ($P < 0.001$) as soaking length increased in alfalfa bud and vegetative orchardgrass hays. Reductions in P, K, and Mg concentrations were observed for the hays, with longer soaking times resulting in greater mineral losses ($P < 0.001$). Based on nutrient requirements, deficiencies would not be expected after feeding hays soaked for 15 to 60 min to a 500 kg horse in light work. However, supplementation of P when feeding hay soaked for 12 h would be necessary to address high Ca:P ratios. Owners and professionals should rely on forage analysis as the primary method of determining the appropriate forage for a horse, especially when feeding a diseased horse.

Key Words: alfalfa, hay soaking, mineral loss, orchardgrass

135 The use of technology to enhance active learning in undergraduate equine nutrition course. R. C. Bott*, K. Koch, and C. Delvaux, *South Dakota State University, Brookings.*

Technology is an effective tool to enhance teaching pedagogies when used appropriately. Two applications of technology were applied to an undergraduate course in equine nutrition to determine if there was a correlation with use of technology and exam performance. An on-line forum board was used to foster interactive learning communities with discussion-based approach to solving 3 case studies (CS) focused on various aspects of equine health and nutrition. Students (n = 48) were allowed one week for each CS to work in small groups, to post 3 or more times for full credit, and then demonstrate cumulative comprehension during a group presentation in class. Readership of relevant sections of the course text was encouraged through the use of student response system (SRS) quizzes with instant feedback. Both applications were incorporated to enhance the formative stages of learning and assessment, and were hypothesized to correlate with increased synthesis of material and performance on examinations. Students averaged 3.6 posts per CS. The number of posts did not differ among CS ($P = 0.26$). The average number of discussion posts (29.9) did not differ from CS one, 2, or 3 ($P = 0.59$), with most posts (18.4) occurring within 48 h of class presentations ($P < 0.005$). Upon completion of these CS, students responded to survey questions on a scale of 1–10 (1 strongly disagree, 10 strongly agree). Students scored enjoying the CS, learning relevant information, and applicability of topics in the real world with a 7.5, 8.7, and 9.1 out of 10, respectively. They ranked the CS on dentition and general nutrition as their favorite, followed by toxic plants, and lastly, minerals and vitamins. Students earned 83.7 ± 2.76% (mean ± SEM) on their CS which correlated to their scores on the first exam, 83.2 ± 1.6% ($P \leq 0.05$). The average scores on the SRS quizzes was 71 ± 2.75% (31 points), which also correlated to exam scores ($P \leq 0.05$). Exams, CS, quizzes, and supplementary homework were weighted to 60, 11, 13, and 16% of the course score, respectively. Active learning was enhanced through on-line case studies and assigned reading as evident by correlations of exams with CS and quiz scores and favorable responses from students.

Key Words: equine, teaching, technology

Extension–Beef/Small Ruminant: Tools for Improving Beef Production Systems

136 DNA markers: What works and how to use them. R. L. Weaber*, *Kansas State University, Manhattan.*

The availability of the bovine genome sequence and the proliferation of instrumentation and methodologies are rapidly transforming the field of livestock genomics. DNA based tools are now used by beef researchers and producers. Short tandem repeats (STR) or single nucleotide polymorphisms (SNP) markers have replaced blood typing as the preferred method of pedigree validation and parent identification by beef cattle breed registries. STR or SNP markers are widely used in diagnostic testing for simply inherited, qualitative traits (horned/polled, red coat carrier) or deleterious recessive genetic defects. DNA markers are used in research and commercial settings to describe genetic variation in quantitative traits with complex phenotypes. Many economic important beef production traits, including growth rate, reproduction and carcass merit, are presumed to be polygenic. Recent work suggests that several hundred markers maybe required to explain a major proportion of the genetic variation in any trait. For many traits, few, if any, genomic regions have been identified that harbor genes of large effect; instead, many are identified with very small effects. The need for the deployment of a new generation of high throughput genotyping platforms producing >700K SNP per animal is a direct consequence of this phenomenon. The new platforms with enhanced resolution will help scientists build useful selection tools for beef cattle through identification of SNP with utility for the across breed prediction of genetic merit. Several breeds are aggressively pursuing convergence of DNA marker information in the form of molecular breeding values (MBV) and legacy pedigree/phenotypic data into genomically enabled national cattle evaluation systems. Such systems optimally combine data to improve the accuracy of EPD predictions for young animals. Improved accuracy allows more precise selection seedstock breeders. MBV are expected to have the most favorable economic impact on traits like feed efficiency, reproduction and animal disease resistance for which observations are expensive and/or difficult to measure yet they have significant roles in herd or producer level profitability.

Key Words: beef cattle, extension, genomics, selection

137 System application of sexed semen. J. B. Hall* and J. B. Glaze Jr., *University of Idaho, Moscow.*

Sexed semen has been utilized by the dairy industry for over a decade. However, availability of sex-sorted semen from beef bulls became a reality only in the last 4 years as flow cytometry-based sorting capacity increased in the industry. Initially, cost of gender selected semen was twice that of conventional semen. Today, several companies now offer sexed semen for $5 to $15 per unit more than conventional semen, making this technology attractive. Current applied research focuses on using sexed semen in several areas – producing replacement heifers or bulls from elite cows, shifting gender ratios to produce more steers, and IVF programs. Over 3 yr, our laboratory used sexed semen to produce replacement heifers with pregnancy rates ranging from 48% to 65% depending on the synchronization system used. Pregnancy rates to sexed semen were reduced 5% to 20% compared with conventional semen. Research from several laboratories report pregnancy rates to fixed timed AI (FTAI) range from 32% to 50%. Estrus synchronization protocols that incorporate a combination of estrus detection and FTAI may be the most appropriate for AI with sexed semen. Considerable variation in pregnancy rate to sexed semen by sire exists. Desired sex gender ratios to single AI service with sexed semen followed by 45 d of nature service averaged 69:31 compared with 51:49 single AI service with conventional semen followed by natural service. Range in percentage desired sex from AI-Natural service combinations was 62% to 78% across years. Use of sexed semen to alter gender ratios in commercial beef herds toward more male calves could increase income from calves sold at weaning by 2% to 5%; however, greater returns to the operation may be realized with retained ownership of calves. Adoption of sexed semen technology in the beef industry may increase rate of genetic improvement, increase production, and enhance income; however, current applications also impart a measure of risk. Additional research on estrus synchronization systems, impacts on profitability, and indicators of fertility for sexed semen are needed.

Key Words: sexed semen, applications, beef

138 Forage treatment methods to improve nutritive value and digestibility. L. L. Berger*, *University of Nebraska, Lincoln.*

High grain price has stimulated renewed interest in methods to improve the digestibility of poor quality forages and crop residues. The 2 major treatment categories involve hydrolytic and oxidative agents. Common hydrolytic agents include sodium hydroxide, ammonia, urea and more recently calcium oxide. Common oxidants are hydrogen peroxide, sulfur dioxide, and sodium chlorite. Combining hydrolytic agents and oxidants can have additive effects. Alkaline-hydrogen peroxide (AHP) treatment of crop residues has the potential to increase dry matter intake and fiber digestibility by over 50%. When diets containing 800 g/kg AHP wheat straw (WS) were fed, sheep ate 3.2% of their body weight and digested 700 g/kg organic matter and 700 g/kg of dietary NDF. Even though steers fed AHP-WS gained slower and less efficiently than those fed corn silage, the actual gains were 235% of projected gains based on the net energy values of untreated WS. Recently research at Illinois, Nebraska and Iowa has shown the potential of CaO to improve the digestibility of crop residues. Illinois research studies were conducted to determine the nutrient digestibility and performance of lambs and steers fed thermochemically (5% CaO) treated crop residues and distillers grains (75:25). A Readco continuous processor was used as the reaction vessel. When lambs were fed WS or corn stover as the residue, treatment increased DM intake and fiber digestibility ($P < 0.05$) When growing steers were fed a corn replacement pellet of treated WS and distillers grains, rates of gain were similar to steers fed corn, but feed efficiency was poorer ($P < 0.05$). DM digestibility was 43% greater for steers fed treated compared with untreated WS diets. The economics of treating poor quality forages is often determined by whether similar amounts of digestible energy can be fed as a supplement for less cost compared with what results from treatment. As the cost of digestible energy increases in response to increasing grain price, treatment of crop residues will become a cost competitive means of increasing animal performance.

Key Words: fiber digestibility, chemical treatment, crop residue

139 Trends in beef consumption: Implications for producers. D. L. VanOverbeke*, M. K. Henderson, and G. G. Hilton, *Oklahoma State University, Stillwater.*

Success in the beef industry relies on consumer beef demand. As such, understanding purchasing behavior and purchasing trends of consumers, retailers and restaurateurs is vital. Overall, beef demand has been declining for the last 30 years. Economic recession and the increasing unemployment rate have created noise around consumer demand, making it hard to determine a true cause of the decline. Because of these economic trends, some consumers have altered their grocery shopping habits and are preparing more meals at home, some consumers are trading down and purchasing cheaper cuts of the same protein source, and some consumers are trading in beef for other options. Even with these changes, 50% of dinners served in American homes in 2010 included a ground or whole meat item and 20.5% of plates contained beef. Since 2008, retail beef sales have increased by 6.9%, with ground beef being the most consumed product. In an effort to capture as much value as possible in the retail sector, beef continues to introduce additional brands into the marketplace. From 2005 to 2010, there was a 24% increase in branded beef offerings in the retail meat case. People with higher incomes tend to consume more beef, which may explain why branded beef programs and natural and organic beef products have not seen a decline in sales in the last 4 years. Restaurants have begun to change menu items to comply with consumers' appetites and financial situations. While overall sales have declined, beef entrees and burgers remain the top 2 menu items, in terms of number of items offered in restaurants, with the most prevalent entree item being a center-of-the-plate steak. Restaurants tend to place great importance on the quality grade of beef they are purchasing, as well as on food safety. Data from the National Beef Quality Audit-2011 will be discussed to report various attributes that both retailers and restaurants require of beef products as well as those attributes that they will pay premiums and discounts for based on consumer demands. Data will help determine if current production practices need to be modified to improve product acceptance in the retail case and on the restaurant menu.

Key Words: beef, consumption, retail, restaurant

140 Defining and quantifying demand for the Certified Angus Beef brand. L. C. Zimmerman*[1], T. C. Schroeder[2], and M. A. McCully[3], *[1]CattleFax, Centennial, CO, [2]Kansas State University, Manhattan, [3]Certified Angus Beef LLC, Wooster, OH.*

Beef demand is a key economic indicator to the beef industry. To determine the impact of premium brands, such as Certified Angus Beef (CAB), on beef demand, quantity, price, population, inflation and demand elasticity data were used to create standardized demand indexes for CAB and USDA Choice wholesale beef. Demand was measured from 2002 to 2010. The elasticity for each model was determined by surveying 20 agricultural economists using a Delphi procedure. An Olympic average of the results was used to estimate elasticity. Elasticity for CAB and Choice product was −0.87 and −0.54, respectively. A 2002 base year was used in each model, and index values are expressed as percentages relative to 2002 demand. CAB demand increased 56% over 8 years, while Choice demand increased 20%. Each beef product experienced its largest year-over-year increase from 2009 to 2010, advancing 38 and 9 percentage points, respectively. International sales positively influence CAB demand. The 2 largest observed CAB international sales years were 2003 and 2010 — the 2 best years for CAB wholesale demand. Brand sales in 2010 increased more than 45.5 million kgs. compared with 2009, and CAB cutout price increased nearly $12 per kg in deflated US dollars. That led to a rare combination of the single largest year-over-year increase in per capita sales and cutout values since 2002, as well as a 2010 demand index all-time high of 154. The CAB and Choice wholesale demand indexes provide a consistent and reliable way to illustrate changing demand over time. Results show demand for premium brands has exceeded commodity Choice and premium products may need consideration in industry metrics for the overall beef demand index.

Key Words: beef demand, choice beef, branded beef

141 The impact and economic analysis of dietary inclusion of citrus pulp on the growth performance, efficiency, carcass merit, and lean quality of finishing pigs. J. D. Crosswhite*, N. B. Myers, A. T. Adesogan, J. H. Brendemuhl, D. D. Johnson, and C. C. Carr, *University of Florida, Gainesville.*

Feed and other input costs have reached such critical levels that fibrous feedstuffs such as citrus pulp, previously determined to be of marginal quality for monogastrics are now being re-evaluated for use in swine diets. Fresh citrus pulp (FP) includes the pulp residue and is approximately 10% dry matter (DM). The FP can be pressed and ground to make pressed pulp (PP) at approximately 20% DM. The PP can be heated and dried to make dried citrus pulp (DCP) at approximately 90% DM. Citrus pulp is often included as an energy supplement for cattle in Florida due to its availability and low cost, with the lower DM forms often being ensiled to improve shelf-life. No known research has evaluated citrus pulp silage with different levels of oil and water on the growth performance, efficiency, carcass merit, and lean quality of finishing pigs. Pigs (n = 40) were fed one of 4 diets for 39 d, a corn soybean meal control diet (CON), or the same diet with DCP, or FP or PP silage replacing 15% of the total diet DM. Pigs were harvested at the University of Florida Meat Laboratory abattoir. Carcasses were fabricated and meat quality measurements were made at 24 h postmortem from the 10th and 11th rib interface of the LM and the gluteus medius (GM) of the ham face. Pigs fed the CON ration had a greater dressing percentage ($P < 0.01$) than FP, DCP, and PP treatments (76.9 vs.75.7, 75.7, and 75.4), respectively. Dietary treatment had no effect ($P \geq 0.05$) on overall average daily gain (ADG), initial or ultimate pH of the SM, LM, or GM, subjective color, firmness, and marbling of the LM and GM, or LM lightness, redness, or yellowness values. Pigs fed ensiled FP had a lower ($P < 0.01$) G:F than the DCP, CON, and PP treatments (0.19, vs. 0.25, 0.24, and 0.24), respectively. Pigs fed FP had a greater ($P < 0.03$) 24 h LM moisture loss percentage than all other treatments, and pigs fed DCP had a lower ($P < 0.03$) 24 h LM moisture loss percentage than all other treatments. Replacing 15% of the total diet DM with citrus by-products had little effect on carcass quality or ADG of pigs.

Key Words: pork quality, citrus, by-products

142 Effect of average litter weight on growth performance, carcass characteristics and meat quality of the offspring. G. Bee*[1] and C. E. Pardo[1,2], [1]*Agroscope Liebefeld Posieux, Posieux, Switzerland,* [2]*ETH Zurich, Department of Agricultural and Food Science, Zurich, Switzerland.*

In a recent study we observed that low (L: < 1.3 kg) average birth weight (BtW) litters carry negative phenotypic traits normally associated with intrauterine growth restriction. It has been suggested that these effects found in normal litter sizes (10–15 total born) resulted from different patterns of prenatal survival. The objective of this study was to investigate if intrauterine growth restriction had long-term effects and thereby affected postnatal performance, carcass characteristics and pork quality. From a population of multiparous Swiss Large White sows (parity 2–6), 16 litters with high (H: > 1.7 kg) or low (L: < 1.3 kg) average litter BtW were selected. At farrowing, from each litter, 2 females were chosen: from the H-sows those with the medium (H-M = 1.80 kg) and lowest (H-L = 1.30 kg) BtW and from L-sows those with the medium (L-M = 1.26 kg) and highest (L-H = 1.49 kg) BtW. From weaning to slaughter at 165 d of age the selected pigs were group-penned and had ad libitum access to the same diets. The number of pigs born alive was similar ($P = 0.22$; L = 13.2 vs. H = 14.1) but the number of weaned pigs was lower ($P = 0.03$; 8.5 vs. 11.6) in L- than H-sows. From birth to slaughter, ADG ($P = 0.28$; 0.58 vs. 0.61 kg/d), ADFI ($P = 0.84$; 1.62 vs. 1.63 kg/d) and feed efficiency ($P = 0.22$; 0.40 vs. 0.41) was similar in L-M and H-M pigs. Except for the heavier belly ($P < 0.01$; 19.33 vs. 18.4%) and the lighter semitendinosus muscle ($P = 0.02$; 401 vs. 473 g) in L-M pigs, carcass characteristics of L-M and H-M pigs were similar. By contrast, L-H pigs tended to grow faster ($P = 0.08$; 0.62 vs. 0.57 kg/d) but ingested more feed ($P = 0.03$; 1.73 vs. 1.49 kg/d) and were therefore less efficient ($P < 0.01$; 0.40 vs. 0.43 kg/kg) than H-L pigs. Carcass weight ($P = 0.05$; 83.9 vs. 75.1 kg) and yield ($P = 0.09$; 81.2 vs. 79.7%) of L-H pigs was greater but percentage lean meat was lower ($P = 0.02$; 54.7 vs. 57.5%) and percentage carcass fat ($P = 0.05$; 7.6 vs. 6.4%) was higher than in H-L pigs. The current results suggest that piglet survival rate during lactation and in part growth efficiency and carcass leanness depends on the average litter birth weight.

Key Words: litter birth weight, growth performance, carcass quality, pig

143 Effects of immunological castration (Improvest) on changes in dressing percentage and carcass characteristics of finishing pigs. D. D. Boler*[1], C. L. Puls[1], D. L. Clark[1], M. Ellis[1], A. L. Schroeder[2], P. D. Matzat[2], J. Killefer[1], F. K. McKeith[1], and A. C. Dilger[1], [1]*University of Illinois, Urbana,* [2]*Pfizer Animal Health, Kalamazoo, MI.*

The objective was to determine which tissues contribute to the reduction in dressing percentage of immunologically castrated (IC) males when compared with surgically castrated males. The dressing percentage of an IC male can be up to 2 percentage units lower than a surgical castrate. This is often attributed to the presence of testicles, but testes only account for approximately 0.25% of live weight. This experiment included surgical castrates, entire males, IC males, and females. Pigs designated for the IC treatment were given injections at 16 and 20 weeks of age. Pigs were eligible for harvest 33 d after the 2nd injection when the average weight of the pen reached 130 kg. Immunologically castrated males lost on average 0.7 percentage units more live weight during 12 to 15 h in transport and lairage than surgical castrates, entires, or females. Dressing percentage of surgical castrates was 1.43 percentage units higher than IC males. Testicle weight accounted for a 0.28 percentage unit reduction in dressing percentage of IC males when compared with surgical castrates. Additional reproductive tract weights accounted for a 0.13 percentage unit difference. Intestinal mass (empty large intestine, small intestine, and stomach) was 0.2 percentage units higher in IC males compared with physical castrates. Livers from IC males were 200 g heavier ($P < 0.05$) and kidneys were 40 g heavier than the same organs in surgical castrates. These 2 organs combined for a 0.15 percentage unit difference in dressing percentage between IC males and surgical castrates. Gut fill, testicles, reproductive tract, intestinal mass, and the liver/kidney accounted for 1.00 of 1.43 percentage unit differences in dressing percentage between IC males and surgical castrates. IC males had less marbling than surgical castrates, but there were no other differences in pork quality. Cutability differences were less than reported in previous experiments, but IC males had a 1.0 percentage unit advantage in lean cutting yield and a 0.7 percentage unit advantage in carcass cutting yield when compared with surgical castrates.

Key Words: dressing percentage, immunological castration

144 Impact of the combination of floor and feeder space in the nursery and of grow-finish floor space on the wean-to-finish growth performance and carcass characteristics of pigs in a commercial facility. C. M. Shull*[1], M. Ellis[1], B. A. Peterson[2], B. F. Wolter[2], and C. M. Peterson[2], *[1]University of Illinois, Urbana, [2]The Maschhoffs, Carlyle, IL.*

The effects of the combination of floor and feeder space during the nursery period and of floor space during the grow-finish period on growth performance and carcass characteristics were evaluated in a commercial wean-to-market facility using a RCBD with a 2 × 6 factorial arrangement of treatments: 1) Nursery floor and feeder space (0.31 m^2/pig and 2.7 cm/pig vs. 0.71 m^2/pig and 5.4 cm/pig); 2) Grow-finish floor space (0.46 vs. 0.51 vs. 0.56 vs. 0.60 vs. 0.65 vs. 0.70 m^2/pig). The study was carried out using 9 replicates with 3,240 pigs in 108 groups of 30 pigs from weaning (6.7 ± 0.42 kg) to a mean pen BW of 120.8 ± 1.41 kg. Pigs had ad libitum access to feed and water throughout the study. Pigs at the reduced floor and feeder space in the nursery period had reduced ($P < 0.05$) nursery and overall ADG (5.9% and 1.0%, respectively) and ADFI (5.4% and 0.9%, respectively), but similar ($P > 0.05$) nursery and overall G:F compared with those at the higher floor and feeder space. Grow-finish ADG, ADFI, and G:F increased quadratically ($P < 0.05$), but total BW gain per unit of floor space decreased linearly ($P < 0.05$) with increasing grow-finish floor space. There was a linear reduction ($P < 0.05$) in 10th rib backfat depth and a linear increase ($P < 0.05$) in predicted carcass lean content as grow-finish floor space decreased. There were no nursery floor and feeder space by grow-finish floor space interactions ($P > 0.05$), suggesting that floor and feeder space in the nursery period have no impact on the response to floor space in the grow-finish period. The results of this study suggest that reducing grow-finish floor space, independent of nursery floor and feeder space, can reduce ADG, ADFI, and G:F, but can increase carcass leanness and total live weight produced per pen.

Key Words: feeder space, floor space, pigs

145 Growth performance of immunologically castrated male pigs (with an anti-GnRF immunological product; Improvest) in comparison to surgical castrates, gilts, and entire males. C. L. Puls*[1], A. Rojo[1], M. Ellis[1], D. D. Boler[1], F. K. McKeith[1], J. Killefer[1], A. L. Schroeder[2], and P. D. Matzat[2], *[1]University of Illinois, Urbana, [2]Pfizer Animal Health, Kalamazoo, MI.*

The impact of immunological castration of male pigs with an anti-GnRF immunological product (Improvest) on growth performance was investigated in a study involving 160 pigs. The study was carried out as a RCBD (blocking factor date of start on test) with 4 treatments: 1) surgically castrated males (SC), 2) entire males (EM), 3) gilts (G), 4) Immunologically castrated males (IC). Start of test was at the time of the first Improvest injection (2 mL of product) (approximately 16 weeks of age; 67.2 ± 2.50 kg BW) and end of test was at 131.7 ± 3.03 kg BW. The second Improvest injection (2 mL of product) was given 4 weeks after the first injection. Pigs were housed in treatment groups of 4 (10 groups/treatment) in a finishing building at a floor space of 1.15 m^2/pig. Diets were formulated to meet or exceed the nutrient requirements of entire males proposed by NRC (1998). Pigs had ad libitum access to feed and water throughout the study period and were individually weighed at start, after 4 weeks, and at end of test. The performance of the pigs is presented in the following table. The results of this study confirm previously observed gender differences in growth performance and also show that immunological castrates have superior growth performance to surgical castrates in the period after the first Improvest injection to harvest weight.

Table 1.

	Treatment					
Item	SC	EM	G	IC	SEM	*P*-value
ADG, g						
Start to Wk 4	1102[a]	1143[a]	968[b]	1121[a]	25.3	<0.001
Wk 4 to End	957[b]	1006[b]	942[b]	1179[a]	36.1	<0.001
Start to End	1024[b]	1064[b]	954[c]	1150[a]	24.6	<0.001
ADFI, kg						
Start to Wk 4	2.92[a]	2.56[b]	2.53[b]	2.57[b]	0.063	<0.001
Wk 4 to End	3.17[b]	2.80[c]	2.90[c]	3.62[a]	0.078	<0.001
Start to End	3.06[a]	2.68[b]	2.75[b]	3.11[a]	0.058	<0.001
G:F						
Start to Wk 4	0.377[b]	0.447[a]	0.383[b]	0.436[a]	0.0063	<0.001
Wk 4 to End	0.302[c]	0.358[a]	0.325[b]	0.326[b]	0.0083	<0.001
Start to End	0.335[c]	0.397[a]	0.347[c]	0.371[b]	0.0063	<0.001

Key Words: growth, immunological castration, pigs

146 Carcass lipid iodine values taken from three carcass sites are affected by dietary fat level and source during the finishing period. T. A. Kellner*, K. J. Pruse, and J. F. Patience, *Iowa State University, Ames.*

The inclusion of unsaturated fats in pig diets has raised issues related to pork carcass lipid quality. The objective of this experiment was to develop a more comprehensive understanding of how dietary fat affects the composition of body fat during the finishing period and at market. A total of 42 gilts and 21 barrows (PIC 337 × C22/29) with an average initial weight of 77.8 ± 3.06 kg were allotted based on sex and weight to 7 treatments: 3 and 6% of each of tallow (TAL; iodine value (IV) = 41.9), choice white grease (CWG; IV = 66.5) or corn oil (CO; IV = 123.1), and a control (CNTR) corn-soy based diet with no added fat. Pigs were individually housed to track dietary fat and energy intake. Pigs were weighed and adipose samples were collected from the jowl, belly, and loin on d 0, 18, and 35 and at harvest. Iodine value was determined on diet and carcass lipid samples. Belly weights were recorded at harvest along with a subjective belly firmness score (1–3 with 1 firmest and 3 least firm) 24 h post-mortem. Data were analyzed using PROC MIXED and PROC CORR. Carcass lipid IV was affected by source (TAL = 66.8, CWG = 70.3, CO = 76.3, CNTR = 65.4; $P < 0.0001$). Carcass lipid IV for TAL and CWG was not affected by inclusion level; however, CO was affected by level (3% = 72.6, 6% = 80.0; $P < 0.0001$). Carcass lipid IV was also affected by sex (barrows = 69.1, gilts = 71.5; $P < 0.001$). The correlation between carcass lipid IV and dietary lipid IV was $R^2 = 0.592$. Belly weight was increased by inclusion level (CNRT = 8.3 kg, 3% = 8.8 kg, 6% = 9.4 kg; $P <= 0.02$). Belly firmness score was affected by source (CNTR = 1.8, TAL = 1.7, CWG = 2.0, CO = 2.2; $P < 0.05$) and sex (barrows = 1.6, gilts = 2.3; $P < 0.0001$). ADG was increased by inclusion level (CNTR = 0.93 kg, 3% = 1.04 kg, 6% = 1.10 kg; $P < 0.02$). G:F was also improved by inclusion level (CNTR = 0.301, 3% = 0.337, 6% = 0.358; $P < 0.01$). In conclusion, an increase of dietary fat can improve feed efficiency and performance. Dietary fat sources that are highly unsaturated will increase carcass fat IV in a dose dependent manner.

Key Words: dietary fat, carcass fat, iodine value, pigs

147 Effects of stocker management system and rate of gain on skeletal muscle developmental characteristics of beef cattle. M. A. Vaughn*[1], J. D. Starkey[1], E. D. Sharman[2], P. A. Lancaster[2], K. C. Hutton[1], U. DeSilva[2], G. W. Horn[2], and C. R. Krehbiel[2], *[1]Texas Tech University, Lubbock, [2]Oklahoma State University, Stillwater.*

To determine the effects of stocker management systems and rate of gain on skeletal muscle developmental characteristics, fall-weaned Angus steers (n = 72; 259 ± 28 kg) from the Oklahoma State University cow herd were randomly assigned to 1 of 4 stocker systems. Stocker systems included: 1) grazing dormant winter native range (NR) supplemented with cottonseed meal (1.0 kg·steer^{-1}·d^{-1}) followed by season-long grazing on summer pasture (CON); 2) grazing dormant winter NR supplemented with a corn-based supplement (1% of BW) followed by short season grazing on summer pasture (CORN); 3) grazing winter wheat pasture at high stocking density (3.0 steers/ha) to produce a moderate rate of gain (LGW); and 4) grazing winter wheat pasture at low stocking density (1.0 steers/ha) to produce high rate of gain (HGW). Steers continued grazing until the average BW of the treatment was 375 kg, at which time steers were adapted to a common finishing diet and fed to backfat thickness of 1.27 cm. Four steers per treatment were harvested at the conclusion the stocker and finishing phases and longissimus muscle (LM) samples were collected. LM were cryosectioned and immunofluorescence stained to determine LM fiber cross-sectional area, fiber type, Pax7+ cell density, capillary density, and nuclear density. At the end of the stocker period, LM fiber cross-sectional area was significantly larger for HGW and LGW steers ($P < 0.01$) compared with CON and CORN steers. In addition, LGW steers exhibited greater nuclear density than those on all other treatments ($P = 0.01$). At final harvest, CON steers tended to have more type 1 muscle fibers ($P = 0.12$) and a greater capillary density ($P = 0.14$) than steers from other treatments. In summary, steers assigned to a stocker management system that produced the lowest rate of gain (CON) developed skeletal muscle characteristics more favorable for marbling deposition at the end of the finishing phase.

Key Words: steer, stocker, muscle growth, marbling

148 Effects of stocker management system and rate of gain on skeletal muscle satellite cell activity in beef stocker cattle. M. A. Vaughn[1], J. D. Starkey[1], K. C. Hutton*[1], E. D. Sharman[2], P. A. Lancaster[2], U. DeSilva[2], G. W. Horn[2], and C. R. Krehbiel[2], *[1]Texas Tech University, Lubbock, [2]Oklahoma State University, Stillwater.*

Our objective was to determine the effect of stocker management system on satellite cell activity in beef cattle. Fall-weaned Angus steer calves (n = 72; 259 ± 28 kg) were randomly assigned to 1 of 4 stocker systems. Stocker systems included: 1) grazing dormant winter native range (NR) supplemented with cottonseed meal (1.0 kg·steer^{-1}·d^{-1}) followed by season-long grazing on summer pasture (CON); 2) grazing dormant winter NR supplemented with a corn-based supplement (1% of BW) followed by short season grazing on summer pasture (CORN); 3) grazing winter wheat pasture at a high stocking density (3.0 steers/ha) to produce a moderate rate of gain (LGW); 4) grazing winter wheat pasture at a low stocking density (1.0 steers/ha) to produce a high rate of gain (HGW). Steers continued grazing pasture until the average BW of the treatment group was 375 kg, at which time steers were transitioned to a common finishing diet and fed to a backfat thickness of 1.27 cm. At the end of both the stocker and finishing phases, 4 steers per treatment were harvested and satellite cells were isolated from the longissimus muscle of each steer. Satellite cells were cultured and proliferation indices and fusion capacity were analyzed. At the end of stocker phase, satellite cell proliferation index was similar among treatments except at 96 h post-plating, when CORN and LGW steers tended to be greater ($P = 0.12$) compared with CON steers, with HGW steers being intermediate. Satellite cells from CON steers had a numerically greater percentage of cells fused into myotubes than other treatments. At final harvest, there were no differences among treatments in the percentage of proliferating satellite cells. In addition, satellite cells from CON steers had the greatest fusion capacity among treatments. Overall, these data suggest that stocker management strategy and rate of gain influence satellite cell-mediated muscle growth in beef cattle.

Key Words: satellite cell, stocker, beef cattle

149 Sequential feeding of β-adrenergic agonists to cull beef cows. M. J. Weber*[1], M. E. Dikeman[1], J. R. Jaeger[1], J. A. Unruh[1], B. J. Johnson[2], and L. Murray[1], *[1]Kansas State University, Manhattan, [2]Texas Tech University, Lubbock.*

Some published research reports reduced density and decreased sensitivity of β-adrenergic receptors (β-AR) in older animals, which might reduce effectiveness of β-adrenergic agonists (β-AA) in realimented cull cows. Supplementation with ractopamine-HCl (RH) during the last 28 d of finishing can increase the abundance of β_2-AR. Zilpaterol-HCl (ZH) primarily elicits a response via β_2-AR. We hypothesized that feeding RH before ZH would upregulate β_2-AR and increase effectiveness of ZH. Sixty cows were used to investigate the effects of feeding a single or sequence of β-AR on performance, mRNA expression, carcass traits, and meat sensory characteristics. Cows were implanted and assigned to 1 of 4 treatments: C = fed a concentrate diet; RH = supplemented with RH the last 25 d before harvest; ZH = supplemented with ZH 20 d before a 3 d withdrawal before harvest; RH + ZH = supplemented with RH 25 d followed by ZH for 20 d before a 3 d withdrawal. The 2 Z treatments averaged 15.3 kg more weight gain than C and RH treatments, and 21 kg more HCW than C but these differences were not significant ($P > 0.10$). The sequence of RH followed by ZH tended to optimize HCW, LMA, % intramuscular fat, and lean color and maturity compared with the ZH treatment. β_2-AR mRNA was increased ($P < 0.05$) in the RH and ZH treatments during the last 20 to 25 d of feeding. Myosin heavy chain (MHC) Type IIa mRNA decreased ($P < 0.05$) from d 24 to 51 in all cows, while MHC-IIx increased ($P < 0.05$) in the ZH and RH + ZH treatments. *Infraspinatus* steaks had improved ($P < 0.05$) WBSF values with β-AA supplementation. *Psoas major* steaks from the RH + ZH treatment were rated most tender. Non-enhanced LM steaks from ZH cows had higher ($P = 0.12$) WBSF values and decreased ($P < 0.0001$) percentage of degraded desmin compared with C and RH cows. Collagen solubility of the LM was increased with ZH supplementation. Enhancement of steaks with 0.1 M calcium lactate improved LM tenderness of β-AA supplemented cows. Implanting and feeding cull cows, regardless of β-AA supplementation, transitioned cows from a cull cow to a white cow market.

Key Words: cull cows, ractopamine-HCl, zilpaterol-HCl, β-adrenergic agonists

150 Combining two proven mechanical tenderness measurements in one steak using two different common cooking methods. Z. D. Callahan*[1], R. M. Dolazza[1], Z. T. Robertson[1], E. M. Callahan[1], K. E. Belk[2], R. K. Miller[3], J. B. Morgan[4], and C. L. Lorenzen[1], *[1]University of Missouri, Columbia, [2]Colorado State University, Ft. Collins,*

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Previous research has demonstrated a moderate relationship between Warner-Bratzler shear force (WBSF) and slice shear force (SSF) when both procedures were performed in the same steak. The objective was to determine the relationship between WBSF and SSF in the same steak using common cooking methods and different cooling times. USDA Select strip loins (n = 240) were aged for either 7 or 14 d to increase variation in tenderness. Each strip loin was then frozen and cut into 2.54-cm steaks. One steak from each loin was allotted to convection conveyor oven (conveyor) and a convection oven (oven). Steaks within each cooking method were further allotted to 4 different cooling times to create the combinations of: WBSF 4 h, SSF 0 h (Trt 1); WBSF 4 h, SSF 4 h (Trt 2); WBSF 24 h, SSF 0 h (Trt 3); WBSF 24 h, SSF 24 h (Trt 4). Steaks were cooked to an internal temperature of 71°C. Five, 1.27 cm cores were used for WBSF and one, 1 × 5 cm slice for SSF. WBSF from steaks cooked with conveyor were tougher than oven cooked steaks (51.9 N vs. 46.1 N; $P < 0.05$). However, SSF were tougher when cooked in oven compared with those cooked with conveyor (267.5 N vs. 237.2 N; $P < 0.05$). Cooling time did not affect shear values ($P > 0.05$) for WBSF or SSF. Correlations for WBSF and SSF performed in the same steak ranged from 0.51 to 0.76 ($P < 0.0001$). Trt 4 had the strongest relationship (0.74; $P < 0.0001$) between WBSF and SSF when using the conveyor method. Trt 1 had the strongest relationship (0.76; $P < 0.0001$) between WBSF and SSF when using the oven method. Performing WBSF and SSF in the same steak was successful based on moderate correlation values but the magnitude of the relationship is dependent on cooking method.

Key Words: shear force, tenderness, beef

151 Influence of standardized ileal digestible tryptophan:lysine ratio on growth performance of 6- to 10-kg nursery pigs. S. Nitikanchana*[1], M. D. Tokach[1], S. S. Dritz[1], J. M. DeRouchey[1], R. D. Goodband[1], J. E. Nemecheck[1], J. L. Nelssen[1], and J. Usry[2], *[1]Kansas State University, Manhattan, [2]Ajinomoto Heartland LLC, Chicago, IL.*

A total of 255 nursery pigs (PIC 327 × 1050, initially 6.3 kg and 3 d postweaning) were used in a 28-d growth trial to determine the effects of standardized ileal digestible (SID) Trp:Lys ratio on growth performance. Treatment diets were fed from d 0 to 14 and a common diet was fed from d 14 to 28. The 6 SID Trp:Lys ratios were 14.7, 16.5, 18.4, 20.3, 22.1, and 24.0%. The diets contained 58% corn, 25% soybean meal, and 10% dried whey and were formulated to 1.30% SID Lys. Pigs were allotted on d 3 after weaning with 6 or 7 pigs per pen and 7 replications per treatment. From d 0 to 14, increasing SID Trp:Lys ratio improved ADG (linear, $P = 0.02$) and generated a tendency for improved ADFI and G:F (linear, $P = 0.06$ and quadratic, $P = 0.08$, respectively). Although ADG and ADFI were linear, the greatest numeric response was observed at a SID Trp:Lys ratio of 20.3%. From d 14 to 28, when the common diet was fed, ADFI increased (linear, $P = 0.05$) as SID Trp:Lys ratio increased in the previous period, but no differences were found in ADG and G:F. For the overall trial (d 0 to 28), ADG and ADFI increased (linear, $P = 0.02$ and $P = 0.03$, respectively) with increasing SID Trp:Lys ratio, with the greatest response observed at 20.3%. Gain:feed was unaffected by SID Trp:Lys ratio. Thus, the SID Trp:Lys ratio for 6- to 10-kg nursery pigs in this study appears to be at least 20.3%.

Table 1. Effects of SIDTrp:Lys ratio on growth performance

	SID Trp:Lys ratio, %							P <	
Item	14.7	16.5	18.4	20.3	22.1	24.0	SEM	Linear	Quadratic
d 0 to 14									
ADG, g	226	244	244	266	258	260	11.67	0.02	0.33
G:F	0.69	0.71	0.71	0.76	0.75	0.72	0.020	0.08	0.08
d 14 to 28									
ADG, g	487	468	489	504	482	501	11.66	0.18	0.88
G:F	0.69	0.67	0.67	0.69	0.68	0.67	0.015	0.65	0.92
d 0 to 28									
ADG, g	356	356	365	385	370	380	8.94	0.02	0.60
G:F	0.69	0.69	0.68	0.71	0.70	0.68	0.012	0.50	0.35

Key Words: amino acid ratio, lysine, nursery pigs, tryptophan

152 Isoleucine requirement in post-weaned piglets. M. Gloaguen*[1,3], N. Le Floc'h[1,2], E. Corrent[3], Y. Primot[3], and J. van Milgen[1,2], *[1]INRA, UMR1079, SENAH, Saint-Gilles, France, [2]Agrocampus Ouest Rennes, UMR 1079, SENAH, Rennes, France, [3]Ajinomoto Eurolysine s.a.s., Paris, France.*

The branched-chain amino acids (BCAA: valine, leucine, isoleucine) are considered to be among the next-limiting amino acids for growth in piglets after Lys, Thr, Met+Cys and Trp. Most studies dealing with the Ile requirement use blood cells as a protein source. Blood cells have a very low Ile content and high or very high Leu and Val contents. However, the BCAA share the first 2 steps of their catabolism and a supply of one BCAA may affect the availability of the other BCAA. The objective of this study was to determine the Ile requirement for growth with a diet without blood cells. Two dose-response studies were carried out with blocks of 6-week-old piglets (12 kg) and performance was monitored during 3 weeks. All diets were sub-limiting in standardized ileal digestible (SID) lysine (1.0%) consisting of 46% wheat, 30% corn, 6% barley and 6% corn gluten meal and differed in the quantity of crystalline L-Ile. In the first experiment, 75 piglets were allotted to 1 of 5 levels of SID Ile:Lys (40, 47, 54, 61, 68%). Addition of Ile up to a level of 47% SID Ile:Lys increased ADG (334, 503, 516, 543 and 509 g/d) and G:F (0.53, 0.62, 0.62, 0.64 and 0.62 g/g). For this study, the Ile requirement could not be determined by regression analysis. A second study was carried out with 84 piglets allotted to 1 of 6 levels of SID Ile:Lys (40, 43, 46, 49, 52, 55%). The supplementation of Ile increased ADG (378, 465, 450, 573, 554 and 545 g/d) and G:F (0.53, 0.57, 0.60, 0.62, 0.60, 0.59 g/g). Maximum ADG and G:F were reached respectively at 49 and 48% SID Ile:Lys using a curvilinear-plateau model. Reducing the SID Ile:Lys content from 49 to 40% resulted in a 32% decrease in ADG. When the diet does not contain blood cells, the Ile requirement may be as low as 49% SID Ile:Lys in post-weaned piglets. With the currently available crystalline amino acids, this recommendation allows further reducing the crude protein content in piglet diets.

Key Words: amino acids, isoleucine, pigs

153 Estimation of the ideal tryptophan:lysine ratio in 10- to 20-kg pigs. G. I. Petersen* and H. H. Stein, *University of Illinois, Urbana.*

Two experiments that were designed to determine the ideal Trp:Lys ratio in 10 to 20 kg pigs were conducted utilizing 2 differing types of diets. In Exp. 1, a corn-corn gluten meal (CGM)-field pea diet was used, and in Exp. 2, a corn-high protein distillers dried grains (HP DDG) diet was used. In both experiments, a basal diet was formulated to contain 0.85% standardized ileal digestible (SID) Lys and 0.10% SID Trp. Five additional diets were formulated in each experiment by adding 0.02, 0.04, 0.06, 0.08, or 0.10% L-Trp to the basal diet. These diets, therefore, contained 11.7, 14.1, 16.5, 18.8, 21.2, or 23.5% SID Trp relative to the concentration of SID Lys. All diets were fed to pigs for 21 d, starting when pigs were 10.32 ± 0.95 kg or 10.05 ± 1.05 kg (Exp. 1 or 2, respectively). In both experiments, estimates for SID Trp:Lys were calculated using a broken line analysis, a quadratic analysis, and the intercept of the broken line and the quadratic line was also determined using ADG, G:F, and plasma urea nitrogen (PUN) as response criteria. In both experiments, there was a linear and a quadratic increase ($P < 0.05$) in final BW, ADG, and G:F, and a reduction (linear and quadratic, $P < 0.05$) in PUN with an increased Trp:Lys ratio. Using broken line analysis, estimates for the ideal Trp:Lys ratio of 20.1, 19.5, and 16.7% were determined in Exp. 1, and estimates of 18.1, 17.4, and 17.0% were determined in Exp. 2 with ADG, G:F, and PUN, respectively, as response criteria. Estimates based on the quadratic analysis were 26.1, 24.0, and 19.1% in Exp. 1, and 21.5, 20.1, and 19.3% in Exp. 2, with ADG, G:F, and PUN, respectively, as response criteria. When the intercept of the broken line and the quadratic analyses were obtained, estimates for the ideal Trp:Lys ratio of 22.2, 22.1, and 18.6% in Exp. 1 and 20.0, 18.9, and 18.6% in Exp. 2, were calculated for ADG, G:F, and PUN, respectively. Based on these data, it is suggested that the ideal SID Trp:Lys ratio in 10 to 20 kg pigs is approximately 18%.

Key Words: ideal protein, lysine, pigs, tryptophan

154 Isoleucine requirement for maintenance in sows. S. Moehn*[1], D. Franco[1], J. K. Josephson[1], P. B. Pencharz[2], and R. O. Ball[1], *[1]Department of Agriculture, Food and Nutritional Sciences, University of Alberta, Edmonton, AB, Canada, [2]Research Institute, Hospital for Sick Children, Toronto, ON, Canada.*

Maintenance AA requirements, previously determined in non-adult pigs, may have increased because of the greater lean content of modern pigs. The objective of this study was to determine the Ile requirement for maintenance using the indicator AA oxidation method. Each of 6 sows, non-pregnant after their 4th litter, received 6 diets based on corn, corn starch and sugar at a mean ADFI of 2.19 kg/d (SE 0.014). Diets were calculated to provide Ile at 10, 20, 30, 50, 60, and 70 mg/kg$^{0.75}$ BW. Sows were confined in respiration chambers overnight before each oxidation study to determine fasting energy expenditure. The ^{13}C background in expired CO_2 was determined for 1.5 h. Sows were fed 2 mg/(kg BW × h) of L[1-^{13}C]Phe over 4 h in 8 half-hourly meals. Expired CO_2 was analyzed for ^{13}C enrichment above background. Requirements were determined as the breakpoint in indicator AA oxidation in 2-phase nonlinear models. Mean sow BW was 219 kg (SE 2.41). The ADG of −0.199 kg/d (SE 0.098) during the 18-d study was not different from zero (P = 0.10). The Ile requirement was 35 mg/d × kg$^{0.75}$ (P = 0.001). Overall Phe retention was less than zero (−0.92 g/d, SE 0.125, P = 0.001) but not different from zero (P = 0.14) for Ile intake above the requirement at −0.53 g/d (SE 0.334). Fasting heat production was 19.3 MJ/d (SE 0.41) or 334 kJ/kg$^{0.75}$ BW (SE 8.5). The mean of fasting and fed heat production was 31.8 MJ/d (SE 0.19) and energy retention was −0.14 MJ/d (SE 0.054), which was not different (P = 0.80) from zero. The fasting and fed respiratory quotient was 1.00 (SE 0.02) and 1.02 (SE 0.02), respectively. Because energy and protein retention were not different from zero, the determined value of 35 mg/d × kg$^{0.75}$ therefore represents the Ile maintenance requirement. The ratio of Ile to the newly determined Lys maintenance requirement (49 mg/kg$^{0.75}$ BW, Samuel et al., 2010) was 0.71: 1 and similar to that suggested by NRC (1998). This indicates that AA maintenance requirements are greater for modern pigs but their ratios remain similar.

Key Words: maintenance, isoleucine, requirement, pig

155 Isoleucine requirement of pregnant sows. S. Moehn*[1], D. Franco[1], J. K. Josephson[1], P. B. Pencharz[2], and R. O. Ball[1], *[1]Department of Agriculture, Food and Nutritional Sciences, University of Alberta, Edmonton, AB, Canada, [2]Research Institute, Hospital for Sick Children, Toronto, ON, Canada.*

Requirements of sows may change in pregnancy because of maternal tissue development and conceptus growth during the different phases of gestation. The objective of this study was to determine the Ile requirement in early (EG, 37 to 61 d) and late (LG, 89 to 109 d) gestation using the indicator amino acid oxidation method. Seven fourth-parity sows were used in EG and LG. Each sow received 6 diets based on corn, corn starch and sugar in both EG and LG at constant ADFI of 2.5 kg/d. Diets in EG contained Ile at 20, 40, 60, 80, 100 and 120% of the Ile requirement (6.2 g/d, NRC 1998) for sows of similar BW, expected maternal gain and litter size, and 60, 80, 100, 140, 160 and 180% in LG. The ^{13}C background in expired CO_2 and plasma free Phe was determined for 1.5 h. Sows were fed 2 mg/(kg BW × h) of L[1-^{13}C]Phe over 4 h in 8 half-hourly meals. Expired CO_2 and plasma free Phe were analyzed for ^{13}C enrichment above background. Requirements were determined as the breakpoint in 2-phase nonlinear models. Sow BW was 246.5 kg in EG and 271.6 kg in LG. ADG was similar in EG (344 g/d) and LG (543 g/d). Sow maternal gain was 19.1 ± 4.4 kg and litters of 17.7 ± 0.75 piglets weighed 22.6 ± 0.87 kg at birth. The Ile requirement was 3.6 g/d (P = 0.001) in EG when Phe retention (−0.59 g/d) and energy retention (−0.31 MJ/d) were not different from zero, indicating that the 4th parity sows had requirements close to maintenance in EG. The Ile requirement in LG was 9.7 g/d (P = 0.001) when sows retained 3.30 g/d of Phe and −1.45 MJ/d of energy. Energy retention was similar in EG and LG, but the respiratory quotient decreased (P = 0.047) from EG (1.05) to LG (0.98) and decreased (P = 0.016) with increasing dietary Ile level, indicating lipid mobilization in LG when Ile was at or above the requirement. The increase in Ile requirement from EG to LG suggests that phase feeding during gestation is necessary. Diets for LG should contain more Ile and be fed at greater allowances than in EG to meet the sows' demands for nutrients.

Key Words: gestation, isoleucine, requirement, sow

156 Tryptophan requirement of gestating sows. S. Moehn*[1], D. Franco[1], J. K. Josephson[1], P. B. Pencharz[2], and R. O. Ball[1], *[1]Department of Agriculture, Food and Nutritional Sciences, University of Alberta, Edmonton, AB, Canada, [2]Research Institute, Hospital for Sick Children, Toronto, ON, Canada.*

Amino acid requirements of sows may change from early (EG) to late (LG) gestation due to the accelerated growth of products of conceptus after d 70 of pregnancy. The objective of this study was to determine the Trp requirement in EG (d 35 to 53) and LG (92 to 111) using the indicator amino acid oxidation method. The same 6 second-parity sows were studied in EG and in LG at a constant ADFI of 2.4 kg/d. Each sow received 6 diets based on corn, corn starch and sugar in both EG and LG at constant ADFI of 2.5 kg/d. Diets in EG contained Trp at 20, 40, 60, 80, 100 and 120% of the Trp requirement (2.5 g/d), for sows of similar BW, maternal gain and litter size, and 60, 80, 100, 140, 160 and 180% in LG. The ^{13}C background in expired CO_2 and plasma free Phe was determined for 1.5 h. Sows were fed 2 mg/(kg BW × h) of L[1-^{13}C]Phe over 4 h in 8 half-hourly meals. Expired CO_2 and plasma free Phe were analyzed for ^{13}C enrichment above background. Requirements were determined as the breakpoint in 2-phase nonlinear models. Sows grew from 167.7 kg (SE 3.93) at breeding to 211.9 kg (SE 5.18) post farrowing. The mean litter size and litter weight were 14.5 piglets (SE 0.43) weighing 19.0 kg (SE 1.41). The Trp requirement of pregnant sows was 1.7 g/d (P = 0.001) in EG and 2.6 g/d (P = 0.016) in LG. Phe retention increased (P = 0.001) from EG to LG, and Phe oxidation (P = 0.029) and body protein breakdown (P = 0.017) decreased from EG to LG. Phe retention and oxidation responded quadratically (P = 0.038) to increasing Trp intake. Heat production and energy retention were not affected (P = 0.92) by Trp intake but increased and decreased, respectively (P < 0.01) from EG to LG. The changes in Trp requirement and energy retention during gestation cannot be adequately met by increasing the feed allowance of a single diet throughout pregnancy. Therefore, phase feeding of 2 diets with different Trp contents is necessary to balance Trp and energy intake with the changing Trp and energy requirements in pregnancy.

Key Words: gestation, sow, tryptophan, heat production

157 Effect of crystalline amino acid supply in a reduced crude protein diet on amino acid utilization and lactation performance of sows. R. Manjarin* and N. L. Trottier, *Department of Animal Science, Michigan State University, East Lansing.*

Considerable effort has been directed toward the design of an optimal dietary AA profile for the lactating sow with the aim of improving milk production. However, no attention has been paid to the mechanisms linking the profile of dietary AA to milk synthesis. Such mechanisms may involve, in part, improved efficiency of AA utilization by the mammary glands. The authors hypothesize that Lys utilization by the porcine mammary glands is increased upon feeding an optimal balance of AA in the presence of lower concentrations of dispensable AA. Expression of genes encoding Lys transporters and milk proteins, as well as transport efficiency of AA, was measured in the mammary glands of lactating sows at different physiological states and under different levels of AA intake. Twenty multiparous sows of similar body weight were fed an optimum profile of AA at 3 levels of CP (9.5, 13.5 and 17.5% (conventional)). Gene expression was analyzed by reverse transcription quantitative PCR using 3 reference genes selected using a novel analytical model developed by the authors. Efficiency of AA utilization for milk production was assessed from mammary AA arterio-venous (A-V) differences and mammary AA transport efficiency (A-V/A × 100). Data was analyzed using a linear mixed model, with significance declared at $P < 0.05$. Feeding a diet with 13.5% CP (20% less CP than in a conventional diet) supplemented with crystalline AA (to achieve an optimal AA profile) increased the efficiency of Lys and Arg transport across the mammary gland and AA utilization for piglet growth. By contrast, expression of genes encoding Lys and Arg transporters was not different across diets. The altered efficiency of Lys and Arg utilization instead was linked to a change in the ratio of arterial Lys and Arg to branched chain AA (BCAA), suggesting competitive inhibition of transport between cationic and BCAA at the cell membrane. Furthermore, the specific Lys and Arg transporter protein CAT-1 was shown to localize to the vascular endothelium, suggesting a potential increase in Arg utilization to modulate blood flow in the mammary glands of sows fed an optimal AA profile within a reduced CP diet.

Key Words: amino acid, lactation, transporter, gene expression

158 Effects of distillers dried grains with solubles (DDGS) on gaseous emissions of finishing pigs. H. J. Kim, S. D. Carter*, M. R. Bible, K. F. Coble, and T. M. Walraven, *Oklahoma State University, Stillwater.*

Two experiments were conducted to determine the effects of feeding DDGS on gaseous emissions by finishing pigs. In each experiment, 80 crossbred pigs were housed in an environmentally-controlled building with 4 identical rooms (20 pigs/room) containing 2 exhaust fans. Airflow and gas concentrations were measured and used to calculate gas emissions. Pigs were stratified by BW, sex, and ancestry, and randomly assigned to 1 of 4 rooms. In Exp. 1, diets were randomly allotted in a 4 × 4 crossover design with 4 rooms and 4 dietary phases. The 4 dietary treatments included corn-soybean meal diets containing 0, 10, 20 or 40% DDGS (88% DM, 27.8% CP, 0.75% S). All diets, within phase, were balanced on standardized ileal digestible Lys and digestible P. Each phase consisted of a 1-wk adjustment period followed by a 3-wk airflow and gas measurement period. Airflow was similar ($P > 0.10$) for all rooms. Increasing DDGS increased (linear, $P < 0.05$) the concentration and emission rates of NH_3, H_2S, CO_2, CH_4, and N_2O in the exhaust air. When calculated on a per pig basis, the emissions of these gases were increased (linear, $P < 0.04$) with increasing DDGS. Emissions of CH_4 and H_2S per pig were increased >200% for pigs fed 40% DDGS. In Exp. 2, pigs were fed either a control diet or a diet containing 25% DDGS (87% DM, 28.6% CP, 0.50% S) for the entire finishing phase. L-Lys HCl, L-Trp, and L-Thr were used to equalize CP content of the DDGS diet with the control diet. Unlike Exp. 1, the concentration and emission of NH_3 was similar ($P > 0.10$) for pigs fed both diets most likely due to the equalization of CP content. However, H_2S concentration and the emission rates of H_2S and CH_4 were increased ($P < 0.06$) by 157% and 188%, respectively, for pigs fed DDGS. The concentration and emissions of CO_2 and N_2O were not affected ($P > 0.10$) by diet. These results suggest that feeding DDGS will markedly increase CH_4 and H_2S emissions; however, NH_3 emissions can be controlled with amino acid use in DDGS diets. This work was partially funded by the National Pork Board.

Key Words: pigs, diet, gaseous emissions

159 Effects of sorghum dried distillers grains with solubles on finishing pig growth performance, carcass characteristics, and fat quality. K. M. Sotak*, T. A. Houser, R. D. Goodband, M. D. Tokach, S. S. Dritz, J. M. DeRouchey, J. L. Nelssen, B. L. Goehring, and G. R. Skaar, *Kansas State University, Manhattan.*

A total of 288 finishing pigs (58.8 kg BW) were used in a 73-d study to determine the effects of sorghum dried distillers grains with solubles (DDGS; 28% CP; 8.0% crude fat) in sorghum- or corn-based diets on growth performance, carcass characteristics, and fat quality. Pigs were allotted to 1 of 6 dietary treatments (6 pens/treatment) which included: sorghum-based diets with 0, 15, 30, or 45% sorghum DDGS (diets 1 to 4 in Table 1.); a sorghum-based diet with 30% corn DDGS (diet 5 28.9% CP, 9.8% crude fat), and a corn-based diet with 30% corn DDGS (diet 6 in Table 1). The diets were formulated to 0.95%, 0.83%, and 0.71% SID lysine in phases 1, 2, and 3, respectively. Overall, increasing sorghum DDGS from 0 to 45% reduced (linear, $P < 0.01$) ADG and increased (linear, $P < 0.01$) backfat iodine value (IV), while fat color became less red (a*; linear, $P < 0.01$) and tended to be less yellow (b*; linear, $P < 0.06$). No differences were observed in growth performance or backfat IV among pigs fed corn- or sorghum-based diets with 30% corn DDGS. However, pigs fed the sorghum-based diet with sorghum DDGS had fat color that was less yellow (b*; $P < 0.03$) than pigs fed the sorghum-based diet with corn DDGS. Pigs fed the sorghum-based diet with 30% sorghum DDGS also had decreased backfat IV ($P < 0.01$) and fat that was whiter (L*; $P < 0.02$) than those fed the sorghum-based diet with corn DDGS. Pigs fed sorghum with 30% sorghum DDGS had decreased ($P < 0.01$) backfat IV than pigs fed corn with 30% corn DDGS. Feeding a sorghum-based diet with 30% sorghum DDGS produces firmer pork fat than those fed corn-based diets with 30% corn DDGS which may have an important role in pork export markets.

Table 1.

	Diet							Linear	Corn DDGS vs. Sorghum
Item	1	2	3	4	5	6	SED	DDGS	DDGS[a]
ADG, kg/d	1.05	1.02	0.99	0.99	1.02	1.02	0.02	0.01	0.88
G:F	0.33	0.33	0.33	0.32	0.34	0.34	0.01	0.26	0.93
Backfat IV	58.7	60.7	64.8	69.2	68.7	68.6	1.23	0.01	0.01
Fat L*[b]	84.8	85.4	85.7	85.4	83.9	84.9	0.70	0.43	0.29

[a]Sorghum grain with 30% sorghum DDGS vs. corn grain with 30% corn DDGS.

[b]L* is on a scale of 0 to 100 (0 = black; 100 = white).

Key Words: corn, DDGS, finishing pigs, sorghum

160 Effects of lowering corn dried distillers grains with solubles (DDGS) and wheat middlings (Midds) with or without the addition of choice white grease (CWG) prior to marketing on finishing pig growth performance, carcass characteristics, carcass fat quality, and intestinal weights. M. D. Asmus*, J. M. DeRouchey, J. L. Nelssen, M. D. Tokach, S. S. Dritz, R. D. Goodband, and T. A. Houser, *Kansas State University, Manhattan.*

A total of 228 pigs (46 kg BW) were used in a 92-d study to determine the effects of withdrawing high fiber diets 19 d before market on growth performance, carcass characteristics, fat quality, and intestinal weights of finishing pigs. Pigs were allotted to 1 of 7 dietary treatments (5 or 6 pens/treatment). Treatments were arranged in a 2 × 3 factorial plus control with main effects of added CWG (0 or 3%) during the withdrawal period (d 73 to 92) and fiber levels of low (corn-soybean meal diet), medium (9.5% Middlings and 15% corn DDGS) or high (19% Middlings and 30% corn DDGS) during the withdrawal period. Pigs were fed high fiber (19% Middlings and 30% corn DDGS) diets from d 0 to 73. Control pigs were fed low fiber corn-soybean meal diets from d 0 to 92. There were no CWG × fiber interactions ($P > 0.13$) except for jowl iodine value (IV) which increased (linear $P < 0.03$) with increasing DDGS and Middlings only when CWG was added to the diet during the withdrawal period. Adding CWG during the withdrawal period increased ($P < 0.02$) ADG (0.82 vs 0.88 kg/d) and G:F (0.29 vs 0.31) leading to an overall (d 0 to 92) improvement ($P < 0.02$) in G:F. Carcass yield and backfat depth increased (linear, $P < 0.05$) when low fiber diets were fed from d 73 to 92. Pigs fed high DDGS and Middlings had increased ($P < 0.001$) jowl IV, with a larger increase when CWG was added. Feeding low levels of DDGS and Middlings during the withdrawal period decreased (linear, $P <$

0.01) whole intestine weights, mainly due to the reduction ($P < 0.02$) in rinsed stomach and full large-intestine weights. Lowering dietary DDGS and Middlings during a 19 d withdrawal period increased yield through reduced large intestine weight and content, improved carcass yield, and jowl IV. The addition of CWG improved G:F; however, CWG did not improve carcass characteristics.

Table 1.

	1	2	3	4	5	6	7	
d 0 to 73:	Low	High	High	High	High	High	High	
					3% Added Fat			
d 73to 92:	Low	Low	Med	High	Low	Med	High	SEM
ADG, kg	0.85	0.84	0.85	0.84	0.86	0.84	0.85	0.013
G:F	0.34	0.33	0.33	0.33	0.34	0.34	0.35	0.004
Final BW, kg	124.5	123.0	123.8	124.0	124.9	124.8	124.5	1.499
Carcass yield, %	72.6	72.6	71.8	71.9	73.0	72.3	71.5	0.305
HCW, kg	90.6	89.4	89.0	89.2	91.2	90.6	88.9	1.332
Lean, %[a]	52.8	53.0	53.3	53.4	53.0	52.6	53.4	0.305
Backfat, mm[a]	18.9	17.5	17.0	17.0	18.6	17.7	16.5	0.603
Jowl IV	69.4	77.8	78.5	79.2	77.3	78.6	81.2	0.502

[a]Adjusted to a common HCW.

Key Words: DDGS, fiber, wheat middlings, pig

161 Effects of feeding diets containing highly oxidized corn dried distillers grains with solubles (DDGS) with increasing vitamin E levels to wean-finish pigs on growth performance, carcass composition, and pork fat quality. R. Song*[1], C. Chen[1], L. J. Johnston[2], B. J. Kerr[3], T. E. Weber[3], and G. C. Shurson[1], *[1]University of Minnesota, St. Paul, [2]West Central Research and Outreach Center, Morris, MN, [3]USDA-ARS-NLAE, Ames, IA.*

Lipid peroxidation in animal feed can reduce growth performance and meat quality. Weanling pigs (n = 432; BW = 6.6 ± 0.4 kg) were used to evaluate the effects of feeding highly oxidized DDGS with 3 levels of vitamin E (α-tocopheryl acetate) on growth performance, carcass composition, and pork fat quality. The DDGS source used in this study contained the highest thiobarbituric acid reactive substances (TBARS) value and peroxide value (5.2 ng/mg oil and 84.1 mEq/kg oil, respectively) among 30 other DDGS sources sampled. Pens within blocks were assigned randomly to 1 of 6 dietary treatments in a 2 × 3 factorial design. Pigs were fed corn-soybean meal (CON) or 30% DDGS diets with 3 levels of vitamin E: none supplemented (No-E), NRC (11 IU/kg, 1X-E), or 10X NRC (110 IU/kg, 10X-E). All diets were formulated on a standardized ileal digestible (SID) AA and available P basis with similar calculated ME content. Compared with CON, inclusion of 30% DDGS in diets reduced ($P < 0.001$) final BW (110 vs. 107 kg), overall ADG (0.76 vs. 0.74 kg/d) and G:F (0.39 vs. 0.37). Increasing dietary vitamin E level increased overall G:F ($P = 0.03$). Hot carcass weight, dressing percentage, backfat depth and loin muscle area were reduced ($P < 0.01$) in pigs fed DDGS compared with CON, but percentage of fat-free carcass lean was not affected. Feeding DDGS increased ($P < 0.001$) PUFA concentration, particularly linoleic acid ($P < 0.001$), and iodine value ($P < 0.001$) in belly fat and backfat compared with pigs fed CON. Dietary vitamin E levels did not affect fatty acid profile in belly or back fat. Alpha-tocopherol concentration in LM was higher ($P < 0.001$) in 10X-E than No-E or 1X-E dietary treatments. Compared with CON, feeding DDGS increased α-tocopherol concentration in LM in pigs fed No-E (1.0 vs. 3.1 μg/g, $P = 0.005$), but not in those fed 1X-E or 10X-E. These results indicate that feeding highly oxidized, 30% DDGS diets to wean-finish pigs may reduce growth performance. However, supplementation of additional vitamin E in the diet did not counteract these effects, but did improve G:F and α-tocopherol level in LM at the 10X NRC level.

Key Words: DDGS, growth performance, pig, vitamin E

162 Effects of dietary L-carnitine and dried distillers grains with solubles (DDGS) on growth, carcass characteristics, and loin and fat quality of finishing pigs. W. Ying*[1], J. M. DeRouchey[1], M. D. Tokach[1], S. S. Dritz[1], T. A. Houser[1], R. D. Goodband[1], J. L. Nelssen[1], and J. C. Woodworth[2], *[1]Kansas State University, Manhattan, [2]Lonza Inc., Allendale, NJ.*

A total of 1,104 barrows and gilts (PIC 337 × 1050, initially 36 kg BW) were used to evaluate the effects of dietary L-carnitine and corn DDGS on growth, carcass traits, and loin and fat quality. Dietary treatments were arranged as a 2 × 3 factorial with main effects of added DDGS (0 or 30% in phases 1, 2, and 3 and 20% in phase 4) and L-carnitine (0, 50, or 100 mg/kg). Each treatment had 7 mixed gender pens with 26 or 27 pigs per pen. Overall (d 0 to 109), pigs fed L-carnitine had increased ($P < 0.02$) ADG and final BW. A DDGS × L-carnitine interaction (quadratic, $P < 0.01$) was observed for G:F. Pigs fed 50 mg/kg L-Carnitine without DDGS had better G:F than pigs fed 0 or 100 mg/kg, but in diets with DDGS, pigs fed 50 mg/kg L-carnitine had poorer G:F compared with those fed 0 or 100 mg/kg. Increasing dietary L-carnitine increased HCW (quadratic, $P < 0.03$), carcass yield (quadratic, $P < 0.07$), and backfat (quadratic, $P < 0.04$), with the maximum response observed at 50 mg/kg. Increasing L-carnitine increased (linear, $P < 0.03$) purge loss of the loin, indicative of decreased water holding capacity. Adding L-carnitine to diets did not affect drip loss, color or marbling score of the loin. Feeding dietary DDGS tended ($P < 0.06$) to decrease visual loin marbling score. Feeding DDGS increased ($P < 0.001$) linoleic acid, PUFA, unsaturated fatty acid:saturated fatty acid ratios, and jowl iodine value; however, feeding L-carnitine did not alter jowl fatty acid profile. In conclusion, feeding L-carnitine improved ADG and HCW, with the maximal response observed at 50 mg/kg, but dietary L-carnitine did not improve loin or fat quality.

Table 1. Effect of L-carnitine and DDGS on growth and carcass traits

DDGS, %:	0	0	0	30	30	30	
L-Carnitine, mg/kg:	0	50	100	0	50	100	SEM
ADG, g	814	853	842	828	845	841	11
ADFI, kg	2.40	2.42	2.47	2.46	2.55	2.41	0.04
G:F	0.34	0.35	0.34	0.34	0.33	0.35	0.01
HCW, kg	92.4	95.4	93.2	92.6	94.2	94.1	0.9
Yield, %	74.7	75.9	75.0	75.0	75.2	75.1	0.3
Loin depth, cm[a]	6.36	6.39	6.34	6.23	6.21	6.23	0.10
Backfat, mm[a]	16.7	17.5	17.2	16.5	17.2	16.5	0.3
Purge loss, %	2.71	3.38	3.47	2.46	2.92	3.45	0.38
Iodine value, g/100g	66.5	66.9	66.9	74.7	73.3	74.0	0.6

[a]Adjusted to a common HCW.

Key Words: DDGS, L-carnitine, pig

163 Effect of replacing soybean meal (SBM) with corn high protein dried distillers grains with solubles (HPDDGS) on growth performance, carcass characteristics, and carcass fat quality in finishing pigs. D. L. Goehring*[1], M. D. Tokach[1], J. M. Nelssen[1], J. M.

DeRouchey[1], R. D. Goodband[1], S. S. Dritz[1], and J. L. Usry[2], *[1]Kansas State University, Manhattan, [2]Ajinomoto Heartland LLC, Chicago, IL*

A total of 204 pigs (PIC 327 × 1050, 58.8 kg BW) were used in a 73-d study to determine the effects of replacing SBM with HPDDGS (33% CP; 9% fat; Lifeline Foods, St. Joseph, MO) and crystalline AA on growth performance, carcass characteristics, and carcass fat quality. Pens were balanced by initial BW and gender (6 pigs/pen) and randomly allotted to 1 of 4 treatments: corn-SBM control, the control diet with 50 or 100% of the SBM replaced with HPDDGS and high levels of crystalline AA (L-Lys, L-Trp and L-Thr), and 100% of SBM replaced with HPDDGS and low levels of crystalline AA. High crystalline AA diets required 30, 27.5, and 17.5% HPDDGS while low crystalline AA diets required 40, 37.5, and 27.5% to replace SBM from 58 to 84, 84 to 109, and 109 to 128 kg, respectively. There were 8 or 9 replications/treatment. Replacing 100% of the SBM with HPDDGS and crystalline AA decreased ($P < 0.02$) ADG, ADFI, carcass yield, and back fat and increased ($P < 0.001$) jowl fat iodine value (IV), but had no effect ($P > 0.45$) on G:F, loin depth, or lean percentage. Replacing 50% of SBM with HPDDGS and crystalline AA did not influence ($P > 0.26$) performance, but increased ($P < 0.001$) IV. Increasing the level of crystalline AA included in the diet when replacing SBM with HPDDGS did not influence performance, but increased ($P < 0.01$) carcass yield and decreased ($P < 0.001$) IV. HPDDGS and crystalline AA can replace 50% of the SBM in finishing diets without negatively effecting performance, or carcass yield. Replacing 100% of SBM with HPDDGS reduced growth rate, but increasing crystalline AA levels can partially help mitigate the negative effects on carcass yield and fat IV.

Table 1. SBM replaced with DDGS

Item	0%	50% with High AA	100% with High AA	100% with Low AA	SEM
ADG, kg	0.95	0.96	0.91	0.90	0.01
ADF, kg	2.91	2.92	2.79	2.77	0.04
G:F	0.328	0.327	0.327	0.326	0.001
Final BW, kg	128.3	128.8	126.2	125.2	1.49
Carcass yield, %	73.1	72.7	72.5	71.6	0.23
HCW, kg	93.8	93.9	91.6	90.0	1.27
Lean %	51.8	51.5	51.5	51.7	0.28
Loin depth, mm	58.1	57.2	55.6	54.6	0.90
Backfat, mm	20.9	21.2	20.8	20.0	0.55
Jowl IV	69.8	72.1	74.8	78.0	0.44

Key Words: amino acids, DDGS, finishing pig

164 Digestibility of neutral detergent fiber, energy and amino acids in nine corn co-products fed to growing pigs. N. Gutierrez*[1], B. J. Kerr[2], and J. F. Patience[1], *[1]Iowa State University, Ames, [2]USDA-ARS-NLAE, Ames, IA.*

An experiment was conducted to determine the apparent ileal digestibility (AID) and apparent total tract digestibility (ATTD) of energy and neutral detergent fiber (NDF), and the AID of AA of 9 corn co-products fed to growing pigs. One source of conventional corn bran (CB-NS; 40.6% NDF), corn bran with solubles (CB-S; 30.9% NDF), corn distillers dried grains with solubles (DDGS) produced conventionally (DDGS-CV; 34.5% NDF), uncooked DDGS (DDGS-BPX; 30.8% NDF), reduced oil DDGS (DDGS-RO; 38.7% NDF), high protein distillers dried grains (HP-DDG; 31.1% NDF), dehulled degermed corn (DDC; 3.8% NDF), corn germ meal (CGmM; 46.2% NDF), and corn gluten meal (CGnM; 12.1% NDF) were used. A total of 20 growing pigs (initial BW: 25.9 Â ± 2.5 kg BW) were fitted with a T-cannula in the distal ileum and allotted to 10 dietary treatment groups in a 4-period incomplete block design with 8 observations per treatment. Treatments included a corn-SBM based basal diet and 9 diets obtained by mixing 70% of the basal diet with 30% of the test ingredient. Fecal and ileal samples were collected from all pigs in each of the 4 14-d periods. Feed was provided at 90% of predicted ad libitum intake. The insoluble non-starch polysaccharides (NSP) content ranged from 61% in CGnM and DDC to 99% in CB-NS. The AID of NDF (19.4% in CB-S vs. 60.6% in CGnM; $P = 0.03$) and GE (30.6% in CGmM vs. 85.6% in DDC; $P < 0.01$), and the ATTD of NDF (6.0% in CB-NS vs. 94.6% in CGnM; $P < 0.01$) and GE (40.5 in CB-NS vs. 99.5% in DDC; $P < 0.01$) were different among the 9 corn co-products. The DE (1,842 in CB-S vs. 5,034 kcal DE/kg of DM in CGnM) and ME (1,816 in CB-S to 4,369 kcal ME/kg of DM in CGnM) were also different ($P < 0.01$). The AID of Lys (11.4% in DDC vs. 65.9% in CGnM) differ ($P < 0.01$) but was not correlated to NDF content. In conclusion, fiber in corn co-products is mostly insoluble, and AID and ATTD of NDF may contribute to differences in energy digestibility of corn co-products. Differences in AID of Lys in corn co-products may be the result of content, solubility, and AID of NDF, as well as processing and addition of solubles during ethanol production.

Key Words: corn co-products, fiber, pigs

165 Effect of dietary fiber from corn bran on growth performance and apparent total tract digestibility of dietary energy in growing and finishing pigs. N. A. Gutierrez*[1], B. J. Kerr[2], and J. F. Patience[1], *[1]Iowa State University, Ames, [2]USDA-ARS-NLAE, Ames, IA.*

An experiment was conducted to determine the effects of dietary fiber from corn bran on growth performance and apparent total tract digestibility (ATTD) of energy in growing and finishing pigs. Corn bran with solubles (23% NDF) was used to increase the dietary fiber level. For both growing and finishing pigs (31.2 ± 1.4 kg BW and 85.4 ± 4.7 kg BW, respectively), 35 barrows and 35 gilts were allotted to 7 dietary treatment groups with 10 replicate pigs per treatment for 28 d. Treatments included a basal corn-SBM diet (NE = 2.39 and 2.50 Mcal/kg for growing and finishing pigs, respectively), and 6 experimental diets formulated with 3 levels of added corn bran (7.5, 15, and 22.5% for growing and 8, 16, and 24% of corn bran for finishing pigs) with (2, 6, or 8%) or without soybean oil to create 3 treatments with constant NE and 3 treatments with declining NE as bran increased. Constant SID Lys:NE ratios (3.85 and 2.33 g/Mcal of NE for growing and finishing pigs, respectively) were maintained across treatments. Pigs were housed individually in pens with free access to feed and water. In growing pigs, BW, ADFI, and ADG were not affected ($P > 0.10$) by corn bran level with constant NE. Body weight (49.5 vs. 47 kg; $P = 0.10$) and ADG (1.04 vs. 0.92 kg/d; $P = 0.06$) showed a tendency to decrease at the highest corn bran level with declining NE. Gain to feed ratio increased ($P < 0.001$) from 0.46 to 0.49 with increasing corn bran and constant NE, and decreased ($P < 0.001$) from 0.46 to 0.43 with increasing corn bran level and declining NE. In finishing pigs, growth performance was not affected ($P > 0.10$) by corn bran level and constant NE, but BW (102.8 vs. 99.4 kg; $P = 0.03$), ADG (1.02 vs. 0.84 kg/d; $P = 0.01$), and G:F (0.33 vs. 0.28; $P < 0.001$) decreased with corn bran level and declining NE. In growing and finishing pigs, the ATTD of GE, DM, and CP decreased (linear, $P < 0.001$) with corn bran level regardless of fat presence in the diet. In conclusion, addition of fat overcomes the detrimental effects of increased fiber on growth per-

formance. In spite of the reduction in ATTD of energy with fiber level, growth performance was not affected with constant NE of the diet.

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

166 The effects of sorghum dried distillers grains with solubles on nursery pig performance. K. M. Sotak*, R. D. Goodband, M. D. Tokach, S. S. Dritz, J. M. DeRouchey, and J. L. Nelssen, *Kansas State University, Manhattan.*

Two experiments were conducted to determine the effects of sorghum dried distillers grains with solubles (DDGS; 32.4% CP; 8.0% crude fat) on nursery pig growth performance. In both experiments, sorghum DDGS were added to corn- or sorghum-based diets. In Exp. 1, 360 nursery barrows (6.8 kg and 26 d of age) were allotted to 1 of 8 dietary treatments (9 pens per treatment) in a 34-d study. Treatments were arranged in a 2 × 4 factorial with main effects of grain source (corn vs. sorghum) and 0, 15, 30, or 45% sorghum DDGS. The diets were formulated to 1.30% and 1.25% SID lysine in phases 2 and 3, respectively and were not balanced for energy. There were no differences among pigs fed sorghum- or corn based diets for ADG and ADFI; however, as sorghum DDGS increased from 0 to 45% of the diet, ADG decreased (linear, $P < 0.01$). A DDGS × grain source interaction (quadratic, $P = 0.03$) was observed for G:F. As sorghum DDGS increased in corn-based diets, G:F was identical for pigs fed 0, 15, and 30% DDGS, but worsened for those fed 45% DDGS. In sorghum-based diets, G:F was best for those fed 0% DDGS, but worsened in pigs fed 15, 30, or 45% DDGS. In Exp. 2, 180 nursery pigs (10.8 kg and 38 d of age) were used in a 21-d study with 5 pens per treatment. Treatments were arranged in a 2 × 3 factorial with main effects of grain source (corn vs. sorghum) and DDGS (0%, 30% corn DDGS; 28.9% CP; 9.8% crude fat, or 30% sorghum DDGS; 32.4% CP; 8.0% crude fat). Diets were formulated to 1.27% SID lysine and were not balanced for energy. Overall, pigs fed sorghum- or corn-based diets had similar ADG (main effect, 520 vs. 513 g/d, respectively). Pigs fed sorghum or corn DDGS had similar ADG, (main effect, 508 vs. 506 g/d, respectively). Pigs fed diets with 30% DDGS gained less ($P < 0.03$) than pigs fed basal diets (507 vs. 535 g/d ADG, respectively). These results suggest sorghum can be a suitable replacement for corn in nursery pig diets, however increasing sorghum DDGS decreased ADG.

Table 1. Exp. 1, evaluating 8 treatments consisting of two grain sources (corn and sorghum) and 4 levels of sorghum DDGS (0, 15, 30, and 45%)

	Corn-based				Sorghum-based				
Item	0	15	30	45	0	15	30	45	SED
d 0 to 14									
ADG, g[d]	313[ab]	302[ab]	294[a]	282[a]	336[b]	308[ab]	286[a]	288[a]	20.9
ADFI, g	465	464	441	412	442	469	440	433	28.7
G:F[e]	0.67[a]	0.66[a]	0.67[a]	0.69[a]	0.76[b]	0.66[a]	0.65[a]	0.67[a]	0.04
d 0 to 34									
ADG, g[d]	488[ac]	478[ac]	466[abc]	430[b]	491[c]	471[ac]	472[ac]	449[ab]	20.4
ADFI, g	757	748	728	694	749	772	765	736	31.5
G:F[e]	0.64[ab]	0.64[ab]	0.64[ab]	0.62[bc]	0.66[a]	0.61[c]	0.62[c]	0.61[c]	0.01

[abc]Means on the same row with different superscripts differ $P<0.05$.
[d]Increasing DDGS; linear, $P<0.01$.
[e]Grain source × DDGS interaction $P<0.05$.

Key Words: corn DDGS, nursery pigs, sorghum, sorghum DDGS

167 Effect of increasing levels of corn distillers dried grains with solubles (DDGS) on growth performance of nursery pigs. T. C. Tsai, C. R. Dove, P. M. Cline, and M. Azain*, *University of Georgia, Athens.*

Two experiments were conducted to evaluate the effect of increasing DDGS (25.9% CP, 10.4% Fat, 7.1% Fiber) in phase 2 and 3 nursery diets on growth performance. The objective was to determine if there was an upper limit of the level of DDGS that could be included in nursery diets. In both experiments, pigs were weaned at 21 d and fed a common phase I starter diet (ME: 3.30 Mcal/kg, CP: 21.68%, Lys: 1.5%) for d 0–7 post-weaning. In Exp 1, a total of 160 pigs (2 trials, 80 pigs per trial, 5 pigs per pen) with initial body weight 6.61 ± 0.5kg were randomly assigned to one of 4 diets: 0% DDGS, 10% DDGS, 20% DDGS, 30% DDGS formulated on a total lysine basis. Test diets were fed in 2 phases (Phase 2: 7–21 d, 3.30 Mcal/kg ME, 1.38% lysine; phase 3: 21–35 d, 3.40 Mcal/kg ME, 1.25% Lysine). In Exp 2, 65 pigs (5 reps per diet, 2–3 pigs per pen, initial BW = 6.77 ± 0.5kg) were assigned to one of 5 diets: 0% DDGS, 10% DDGS, 20% DDGS, 30% DDGS, 37.5% DDGS, and 45% DDGS, that were formulated on a standardized ileal digestible lysine basis and fed in 2 phases (phase 2: 7–21 d; 3.30 Mcal/kg ME,1.20% SID lysine; phase 3: 21–35 d, 3.40 Mcal/kg ME,1.01% SID lysine). Energy, protein and phosphorus digestibility were also determined in Exp 2 using TiO2 as a marker. In Exp 1, there was no change in ADG in phase 2 as DDGS increased from 0 to 30% (274, 286, 269, 242 g/d, NS), however, ADG decreased linearly in phase 3 (559, 545, 525, 480, g/d, $P < 0.001$) and overall (D 7–35: 416, 415, 398, 316. g/d, $P < 0.001$). Intake (ADFI) increased with increasing DDGS in phase 2 (468, 533, 555, 557 g/d $P < 0.05$), but was not changed ($P > 0.2$) in phase 3 (average = 883 g/d) or overall (average 705 g/d). In Exp 2, increasing DDGS up to 45% had no significant effect in ADG or ADFI ($P > 0.20$). Apparent digestibility of energy ($P < 0.001$) and protein ($P < 0.01$) decreased in both phase 2 and 3 as DDGS increased. Phosphorus digestibility improved ($P < 0.001$) with increasing DDGS. The results indicate that high levels of DDGS can be used in nursery diets and are well tolerated if the diets are formulated on a constant SID lysine basis with a balanced amino acid pattern.

Key Words: DDGS, growth performance, nursery pigs, nutrient digestibility

168 Effects of increasing dietary wheat middlings and corn dried distillers grains with solubles in diets for 7- to 23-kg nursery pigs. J. A. De Jong*, J. M. DeRouchey, M. D. Tokach, R. D. Goodband, S. S. Dritz, and J. L. Nelssen, *Kansas State University, Manhattan.*

Three experiments were conducted to determine the effects of dietary wheat middlings (middlings) and corn dried distillers grains with solubles (DDGS; 29.5% CP; 9.5% fat) on nursery pig performance. For all experiments, pigs were allotted to pens based on BW at weaning (21 d of age) with pens allotted to treatments based on pen weight on d 0 of the experiment. Composition of middlings ranged from; 16.0 to 16.5% CP, 9.8 to 11.0% ADF, 30.6 to 33.7% NDF, and 7.9 to 8.5% CF. Diets had constant SID Lys, but were not isocaloric. In Exp. 1, 180 pigs (12 kg BW) were used in a 21-d trial and fed diets containing wheat middlings. Increasing wheat middlings decreased ADG (linear; $P < 0.05$; 578, 568, 565, 566, 547 g/d) and ADFI (linear; $P < 0.005$; 945, 941, 903, 916, 892 g/d) with no change in G:F. In Exp. 2, 180 pigs (12 kg BW) were fed 1 of 6 experimental diets arranged in a 2 × 3 factorial with main effects of DDGS (0 or 20%) and middlings (0, 10, or 20%)

for 21-d. There were no DDGS × middlings interactions and adding DDGS to the diet did not influence ADG (577 vs. 571 g/d), ADFI (942 vs. 939 g/d), or G:F (0.61 vs. 0.61). Increasing wheat middlings decreased (linear, $P < 0.03$) ADG (589, 573, 556 g/d), G:F (0.63, 0.61, 0.60), and final BW (24.6, 24.3, 24.0 kg) with no difference in ADFI. In Exp. 3, 210 pigs (7 kg BW) were used in a 35-d trial to evaluate the effects of increasing wheat middlings (0, 5, 10, 15, and 20%) on 7- to 23-kg pig performance. From d 0 to 14, increasing middlings did not affect ADG (205, 210, 213, 200, 209 g/d) or G:F (0.62, 0.67, 0.67, 0.63, 0.63). From d 14 to 35, increasing middlings decreased (linear; $P < 0.02$) ADG (585, 585, 578, 569, 543 g/d) and G:F (0.67, 0.68, 0.66, 0.66, 0.63). Overall increasing middlings tended (linear; $P < 0.11$) to decrease ADG (433, 435, 432, 422, 408 g/d) and decreased (quadratic; $P < 0.01$) G:F (0.66, 0.68, 0.66, 0.66, 0.63) with no difference in ADFI. The greatest reductions in ADG and G:F were observed when wheat middlings exceeded 10 and 15% of the diet, respectively. In conclusion, feeding increasing middlings to 7- to 23-kg pigs decreased growth performance; however, effects were minimal until over 10% middlings were added to the diet.

Key Words: DDGS, growth, nursery pig, wheat middlings

Invited Symposium: Physiology of Heat Stress in Production Animals

169 Infertility in heat-stressed dairy cattle: Causes and mitigation. P. J. Hansen*, *University of Florida, Gainesville.*

Heat stress can compromise reproduction by reducing expression of estrus, compromising oocyte competence for fertilization and development, blocking embryonic development, and increasing pregnancy loss in the late embryonic and fetal periods. Lactating dairy cows are particularly sensitive to heat stress because of the large amounts of metabolic heat produced as a result of lactation. The mechanisms responsible for reduced expression of estrus are not well defined but probably involve reductions in the preovulatory rise in estradiol and lethargy. In any case, effects of heat stress on estrus detection can be prevented by incorporation of a timed artificial insemination program. Such a program does not improve fertility, however. Low pregnancy rates per insemination during heat stress are a result, in large part, of damage to the oocyte and cleavage stage embryo. Because folliculogenesis takes over 90 d for completion, heat stress occurring many days before estrus can compromise fertility. After fertilization, embryos are very susceptible to elevated maternal temperature from the 1-cell to 8-cell stage but then acquire thermoresistance to elevated temperature. Damage to the embryo caused by heat stress involves actions of reactive oxygen species and the early cleavage stage embryo has low concentrations of glutathione, a key cytosolic antioxidant. Effects of heat stress on fertility can be greatly reduced or eliminated by the use of embryo transfer because the blastocyst-stage embryo used for transfer is largely resistant to disruption by maternal hyperthermia. Embryo transfer, in fact, remains the only demonstrated method to improve fertility during heat stress. No hormonal treatment for doing so has been identified. There is some evidence that feeding additional quantities of antioxidants can improve pregnancy rate during heat stress but more work is necessary to confirm this finding and reduce it to practice. There are also genes controlling regulation of body temperature and embryonic responses to elevated temperature. Therefore, it should be possible to select genetically for thermotolerance.

Key Words: heat stress, dairy cattle, reproduction, fertility

170 Management of heat stress in the livestock industry. T. M. Brown-Brandl*, *USDA-ARS US Meat Animal Research Center, Clay Center, NE.*

Heat stress costs the animal industry over $1.7 billion annually. Annual losses average $369 million in the beef cattle industry and $299 million in the swine industry. The impacts of a single heat stress event on individual animals are quite varied. Brief events often cause little or no effect. Moderate events cause reductions in feed intake, growth, and well-being. Extreme events can lead to death of vulnerable animals. The level of heat stress an animal experiences can be broken down into 3 primary factors: animal susceptibility, environmental conditions, and management strategies. Many management strategies have been developed for the beef feedlot industry; however, due to the costs associated with their implementation, very few are being used. Breaking down the problem of heat stress into its core components may aid in development of new applications of existing strategies. This presentation will provide an overview of the positive and negative aspects of current management strategies, and will discuss how precision animal management techniques might impact management strategies within the livestock industry.

Key Words: heat stress, animal susceptibility, temperature, management

171 The physiology of heat stress: A shift in metabolic priorities at the systemic and cellular levels. R. P. Rhoads*[1] and L. H. Baumgard[2], [1]*Virginia Polytechnic Institute and State University, Blacksburg,* [2]*Iowa State University, Ames.*

Heat stress (HS) compromises efficient animal production resulting in a significant financial burden to agricultural industries. Reduced performance in terms of lactation and lean tissue accretion during HS has traditionally thought to result from the common animal response of reduced nutrient intake during environmental-induced hyperthermia. Recent studies have begun to challenge this notion with observations indicating heat-stressed animals may exploit novel homeorhetic strategies to direct metabolic and fuel selection priorities independently of nutrient intake or energy balance. Alterations in systemic physiology support a shift in metabolism, both on whole-body as well as tissue specific level. Such changes are marked by increased basal and stimulated circulating insulin levels in addition to the apparent lack of basal adipose tissue mobilization coupled with a reduced responsiveness to lipolytic stimuli. Liver and skeletal muscle cellular metabolism also show clear differences in glucose production and use, respectively due to HS. The apparent dichotomy in intermediary metabolism between the 2 tissue types may stem from factors such as mitochondrial function and anti-oxidant capacity. Thus, the HS response markedly alters post-absorptive carbohydrate, lipid and protein metabolism independently of reduced feed intake through coordinated changes in fuel supply and utilization across tissues. Perhaps most intriguing is that the coordinated systemic, cellular and molecular changes appear conserved among different species and physiological states. Ultimately, these changes result in the reprioritization of fuel selection during HS, which may be important for whole-body metabolism and overall physiological adaptation to hyperthermia.

Key Words: heat stress, metabolism, liver, skeletal muscle

Ruminant Nutrition: Maternal Nutrition–Impacts on Production

172 Effects of limit-feeding dried distillers grains during mid- to late-gestation on ewe and progeny performance pre-weaning. R. L. Burgett*[1], J. S. Luther[2], D. M. Schaefer[1], M. A. Berg[1], D. L. Thomas[1], and A. E. Radunz[1], *[1]University of Wisconsin, Madison, [2]University of Wisconsin, River Falls.*

Mature pregnant Polypay and Hampshire ewes (n = 48; BW = 83.1 ± 2.7 kg) were used to evaluate the effects of maternal dietary energy source fed during mid- to late-gestation on postnatal progeny performance. Ewes were blocked by breed (n = 2) and then BW (n = 3), stratified by, age, sire, and fetal number, and then randomly assigned to pens (n = 12). Pens were allocated to 1 of 2 treatments: ad libitum alfalfa hay (H) or limit-fed dried corn distillers grains plus solubles (D) as the primary dietary energy source from 63 to 130 ± 6 d of gestation. Diets were formulated to provide 3.5 Mcal ME/d at the start of the trial and ewes fed D were offered 1.50 kg/d of D, 0.20 kg/d alfalfa hay, and 0.05 kg/d mineral supplement on DM basis. Amount of DM offered of D was adjusted biweekly to maintain similar BW gain as ewes fed H. At d 130 of gestation, ewes were removed from experimental treatments and managed similarly until lambing. At parturition, ewe BW and BCS were collected and colostrum yield was determined on a subset of ewes (n = 20). After lambing, ewes and lambs were managed together until weaning (66 ± 9 d of age). At 40 d postpartum, 3 h milk yield was measured. Initial and final ewe BW were similar ($P \geq 0.44$) between H and D treatment groups, however ewes fed D had greater ($P = 0.03$) ADG than ewes fed H. At parturition, ewe BW, BCS, and length of gestation was not influenced ($P \geq 0.12$) by gestation dietary energy source. Ewes fed H tended to yield more ($P = 0.08$) colostrum than ewes fed D. A breed x treatment interaction was detected for dystocia whereas Polypay ewes fed D had greater ($P = 0.02$) dystocia scores than Hampshire ewes fed D or H. Progeny birth weight and placental tissue mass was similar ($P = 0.18$) between treatments. At 40 d postpartum, no differences were detected ($P \geq 0.42$) in milk yield, ewe BW, or ewe BCS between treatments. For progeny from ewes fed D and H, BW and ADG were similar ($P \geq 0.77$) at weaning. Although differences were detected in dystocia, D may be used as an alternative energy source during mid- and late-gestation for ewes without detrimental effects on pre-weaning growth of progeny.

Key Words: distillers grains, fetal programming, gestation, sheep

173 Influence of prepartum diet type on cow performance and subsequent calf performance. T. B. Wilson*, D. W. Shike, D. B. Faulkner, T. G. Nash, and N. Post, *University of Illinois, Urbana-Champaign.*

Spring-calving, mature Angus, Simmental, and Simmental × Angus cows (n = 191) were utilized to evaluate the effects of prepartum diet type on cow and subsequent calf performance. Cows were blocked by BW and calving date into 16 pens and allotted to isocaloric, isonitrogenous dietary treatments: corn coproducts and ground cornstalks (COP) or ground hay (Hay). Treatment diets were fed from 90d prepartum to calving. All cows were fed a common diet postpartum. Cow BW and BCS were taken at beginning of feeding period, calving, and breeding. Calf BW was taken at birth and 56d intervals from the average calving date. Milk production was determined utilizing the weigh-suckle-weigh technique on d 56 and d 112. On d112, steers and non-replacement heifer calves (n = 87) were weaned and placed on a common feedlot diet with individual feed intake monitored using GrowSafe. Feedlot calves were harvested at a commercial facility when 12th rib fat thickness (BF) reached 1.1 cm. Initial cow BW and BCS were not different ($P > 0.92$). At calving, cow BW trended higher ($P = 0.08$) and BCS was greater ($P < 0.01$) for COP cows. For COP, trends for increased calf birth BW ($P = 0.06$) and calves born dead ($P = 0.08$) coincided with numerically lower unassisted births ($P = 0.13$). Hay fed cows also tended to be lighter ($P = 0.07$) at breeding with lower BCS ($P = 0.05$); nevertheless, overall conception rate was not different ($P = 0.83$). No differences ($P \geq 0.42$) in milk production were detected. Weaning BW, final BW, and days on feed were not different ($P \geq 0.19$); and as result, no difference in feedlot ADG ($P = 0.68$) was detected. Feedlot DMI and G:F were not different ($P \geq 0.48$) across treatments. Calf health was monitored in the feedlot with no differences ($P \geq 0.76$) in mortality or morbidity observed. No differences ($P \geq 0.45$) were detected for HCW, LMA, BF, marbling score, yield grade, or KPH. No differences ($P \geq 0.32$) in quality or yield grade distribution were observed. Prepartum cow diets formulated to be isocaloric and isonitrogenous do not affect performance and carcass traits of subsequent offspring.

Key Words: cow, gestation, fetal programming

174 Nutritional programming of the dairy calf and lactation milk yield. F. Soberon* and M. E. Van Amburgh, *Cornell University, Ithaca, NY.*

Pre-weaning nutrition and management of dairy calves is generally focused on rumen development, starter intake and disease management. Much data has been generated on the mechanisms and rate of rumen development to improve health and reduce the cost of feeding the calf. However, recent multi-species data has shown that post-natal management and nutrition can have a profound and long lasting effect through epigenetic mechanisms that enhance lifetime performance, health and productivity. We conducted a retrospective study of 2 farms in NY with 8 yr of data using a mathematical approach generally applied to genetic evaluation of cattle and used the outcome of that evaluation to further analyze early life growth and level of pre-weaning nutrient intake on multi-lactation milk yield. The data demonstrated a strong positive correlation between pre-weaning average daily gain (ADG) and lifetime milk production. The relationship between ADG and milk yield was positive and linear and resulted in 850 and 1,113 kg more milk during first lactation for every kg of ADG before weaning for each farm. A further analysis was conducted evaluating energy intake above maintenance from milk replacer and for every additional Mcal above maintenance heifers produced 235 kg more milk during first lactation. Furthermore, in one of the farms, pre-weaning ADG explained 22% of the variation in milk yield during first lactation. Metabolic programming appears to work through different mechanisms and it can be influenced by both colostrum and early life nutrition. For example, published effects of colostrum and overall nutrient intake include increased feed efficiency, increased DMI as well as increased proliferation of mammary epithelial cells. In 3 published studies enhanced proliferation of mammary epithelial cells has been observed in calves fed higher levels of milk replacer intakes. This observation has only been seen during the pre-weaning period and suggests that the reports of isometric growth during the pre-weaning period are a direct outcome of level of nutrient intake before weaning.

Key Words: pre-weaning nutrition, milk production, dairy calf

175 Correlation of feed efficiency and small intestinal growth in finishing cattle born to dams fed varying levels of nutrients during early to mid-gestation. A. M. Meyer*[1], K. M. Cammack[1], S. I. Paisley[1], P. Moriel[1], W. J. Means[1], M. Du[1], J. S. Caton[2], and B. W. Hess[1], *[1]Department of Animal Science, University of Wyoming, Laramie, [2]Department of Animal Sciences, North Dakota State University, Fargo.*

We hypothesized that gestational nutrition would affect calf feed efficiency and small intestinal growth, and that feed efficiency would be correlated with small intestinal growth. Multiparous beef cows (n = 36; 497.9 ± 8.2 kg BW) were fed 1 of 3 diets from d 45 to 185 of gestation: a control (CON) diet of native grass hay and supplement to meet NRC recommendations, a nutrient restricted (NR) diet providing 70% of CON NE_m, or an NR diet with a ruminally undegradable protein supplement to provide similar essential AA as CON. Individual feed intake of calves was measured with the GrowSafe System during finishing. At slaughter (552.4 ± 10.2 kg BW), the small intestine was dissected and sampled. Data were analyzed with calf sex as a block in a mixed model. There was no effect ($P \geq 0.52$) of maternal nutrition on residual feed intake (RFI), G:F, or intake. As previously reported, maternal nutrition affected calf small intestinal length, but not intestinal mass, cellularity, or proliferation. Despite this, RFI was positively correlated ($P \leq 0.08$) with jejunal mass (r = 0.35), small intestinal mass (r = 0.33), and total jejunal DNA content (r = 0.33), and was negatively correlated ($P \leq 0.09$) with jejunal mucosal density (r = −0.33) and DNA concentration (r = −0.34). Gain:feed was positively correlated ($P \leq 0.09$) with jejunal mucosal density (r = 0.42), jejunal DNA (r = 0.32) and protein (r = 0.40) concentrations, and total jejunal DNA (r = 0.34), protein (r = 0.39), and cells (r = 0.34). Jejunal RNA concentration (r = −0.44), RNA:DNA (r = −0.52), and total RNA (r = −0.37) were each negatively correlated ($P \leq 0.05$) with G:F. Intake was positively correlated ($P \leq 0.09$) with jejunal (r = 0.75), ileal (r = 0.34), and total small intestinal (r = 0.74) mass; small intestinal length (r = 0.32); and total jejunal DNA (r = 0.52), protein (r = 0.55), and cells (r = 0.52). Small intestinal size and growth explains some variation in efficiency of nutrient utilization in feedlot cattle. Thus the small intestine is a potential target for development of strategies to improve feed efficiency.

Key Words: feed efficiency, gestation, small intestine

176 Effects of nutrient restriction and melatonin supplementation during mid- to late gestation on ewe and fetal lamb small intestinal and hepatic in vitro oxygen (O_2) consumption. A. M. Meyer*[1], K. C. Swanson[2], B. J. Awda[3], M. Kapphahn[2], R. D. Yunusova[2], L. E. Camacho[2], J. S. Caton[2], K. A. Vonnahme[2], and C. O. Lemley[2], *[1]Department of Animal Science, University of Wyoming, Laramie, [2]Department of Animal Sciences, North Dakota State University, Fargo, [3]Department of Animal and Poultry Science, University of Guelph, Guelph, ON, Canada.*

To determine the effects of nutrient restriction and melatonin supplementation on ewe and offspring small intestinal and hepatic O_2 consumption, 32 primiparous ewes were allocated on d 50 of gestation to receive either 60% (RES) or 100% (ADQ) of NRC recommendations with 0 (CON) or 5 mg/d (MEL) of dietary melatonin. At d 130 of gestation, ewes and fetuses were euthanized and jejunal and hepatic tissues were collected for in vitro O_2 consumption determination. Data were analyzed as a completely randomized design with a 2 × 2 factorial arrangement of treatments using the mixed procedure of SAS. Ewe jejunal and hepatic masses were decreased ($P < 0.001$) by RES but unaffected by MEL. Nutritional plane and melatonin supplementation interacted to affect ($P \leq 0.04$) jejunal O_2 consumption, both per unit of tissue (μmol/min/mg) and jejunum (μmol/min, μmol/min/kg empty BW). Jejunal tissue of CON-RES ewes consumed more ($P = 0.001$) O_2 per unit than CON-ADQ, whereas MEL-ADQ had greater ($P < 0.03$) total jejunal O_2 consumption than MEL-RES and CON-ADQ. Relative to empty BW, CON-ADQ ewes had less ($P \leq 0.01$) jejunal O_2 consumption than CON-RES and MEL-ADQ. Ewe hepatic O_2 consumption per unit was unaffected ($P > 0.75$), but total hepatic O_2 consumption was decreased ($P < 0.001$) in RES. Fetal small intestinal mass and O_2 consumption (per unit and total) were affected ($P \leq 0.03$) by the interaction of nutritional plane and melatonin supplementation. Small intestinal mass of MEL-ADQ fetuses was greater ($P = 0.001$) than MEL-RES, whereas CON-RES had greater ($P \leq 0.02$) O_2 consumption per unit than all others. Additionally, CON-RES fetuses had greater ($P \leq 0.03$) total small intestinal O_2 consumption than CON-ADQ and MEL-RES and greater ($P \leq 0.05$) small intestinal O_2 consumption relative to BW than all others. Fetal hepatic mass and total hepatic O_2 consumption were decreased ($P \leq 0.01$) for RES. Maternal nutrient restriction and melatonin supplementation interacted to alter small intestinal O_2 consumption, and ultimately energy use, of both the dam and offspring.

Key Words: energy use, gastrointestinal tract, gestational nutrition

177 Maternal nutrition and dietary supplements that affect uteroplacental blood flow and fetal development. C. O. Lemley*[1], L. E. Camacho[1], C. A. Zimprich[1], L. A. Lekatz[1], J. S. Caton[1], P. Shukla[2], S. T. O'Rourke[2], and K. A. Vonnahme[1], *[1]Department of Animal Sciences, North Dakota State University, Fargo, [2]Department of Pharmaceutical Sciences, North Dakota State University, Fargo.*

Livestock raised for red meat production spend 35 to 40% of their life in the uterus, being nourished primarily by the placenta. Compromised placental function can result in fetal growth restriction which is associated with greater risk of neonatal morbidity and mortality. Large increase in transplacental nutrient and waste exchange, which supports the exponential increase in fetal growth during the last half of gestation, are dependent primarily on the rapid growth and vascularization of the uteroplacenta. Currently, our laboratory is examining maternal nutritional plane along with dietary supplements, such as protein or melatonin supplementation, which impact placental vascularization, blood flow, and fetal development. In cattle, nutrient restriction during early to mid-gestation followed by realimentation alters placental vascularity and function. In addition, gravid uterine artery vascular resistance decreased during late gestation in cows fed nutrient restricted diets from early to mid-gestation. In ewes, nutrient restriction during the last half of gestation decreased uterine artery blood flow as well as fetal consumption of glucose and amino acids. In contrast, placental utilization of glucose is increased in nutrient restricted sheep during late gestation. Dietary melatonin supplementation increased umbilical cord blood flow irrespective of maternal nutritional plane, which may be dependent on increased responsiveness of placental arteries to the vasodilator, bradykinin. Protein supplementation during late gestation may have lasting consequences on offspring growth and performance, which may be mediated by uteroplacental hemodynamics and placental nutrient transfer capacity. In sheep, protein supplementation decreased uterine artery blood flow, which may be due to decreased placental vascular responsiveness to bradykinin. In contrast, protein supplementation in cows increased uterine artery blood flow. Elucidating the consequences of inadequate maternal intake or dietary supplementation on the continual plasticity of placental function will allow

us to determine the proper timing and duration for intervention and rescue.

Key Words: placenta, umbilical blood flow, uterine blood flow

178 Impact of maternal nutrition on subsequent steer and heifer progeny. R. N. Funston*, *University of Nebraska, North Platte.*

Maternal stimuli or an insult during a critical period of fetal development having long-term implications for the offspring is the concept of fetal programming. Much of the evidence regarding how maternal nutrient restriction affects prenatal physiological parameters was generated in laboratory animals. Few studies have evaluated effects of maternal nutrient restriction on postnatal growth and development in livestock species. The beef cattle industry relies on the utilization of high forage diets to maintain the cow herd. Forage quantity and quality fluctuate with season and environmental conditions. A grazed forage diet may not always meet nutritional requirements resulting in low ADG or weight loss if supplemental nutrients are not provided. It is important to understand the consequences of such weight loss and the economics of providing supplementation to the beef production system. A rapidly evolving body of literature is demonstrating effects on subsequent offspring developing in a restricted environment in utero. In recent studies at the University of Nebraska, calf birth weights were unaffected while calf weaning weights were greater from cows gestated on dormant winter range receiving protein supplementation during late gestation compared with nonsupplemented cows. Subsequent steer carcass weights and quality grades were also improved in calves born to supplemented dams and more heifers from supplemented dams were pubertal before breeding and had greater pregnancy rates. This body of research provides compelling evidence of a fetal programming response to maternal nutrition in beef cattle. Future competitiveness of the beef industry will continue to be dependent on the utilization of high forage diets to meet the majority of nutrient requirements. Consequences of nutrient restriction must be considered not only on individual animal performance but also the developing fetus.

Key Words: Beef cattle, fetal programming, nutrition, supplementation

344 Impacts of maternal nutrition on the expression of genes involved in the regulation of muscle and adipose growth and tenderness. K. R. Underwood*[1], A. D. Weaver[1], and A. E. Wertz-Lutz[2], *[1]South Dakota State University, Brookings, [2]ADM Alliance Nutrition Inc., Quincy, IL.*

The fetal origins hypothesis states that a stress or insult during gestation will cause fetal adaptations that can affect the animal later in life. The most common insult or stressor to livestock species would be altered plane of nutrition during gestation, which can ultimately affect fetal development. During embryonic and fetal development, there is a tremendous draw of nutrients to meet the demands of the developing fetus, and alterations in the composition of the offspring can result if these demands are not satisfied. This is extremely important agriculturally as skeletal muscle provides a high quality protein source in human diets, and intramuscular fat and tenderness affect the quality of that nutrient source. Being that muscle, fat, and connective tissue develop from the same pool of cells known as mesenchymal stem cells, any shift from one tissue to another would likely cause a change in body and carcass composition of the offspring. Additionally, intramuscular fat, or marbling, has a strong correlation to beef carcass value in the current USDA Grading system. Therefore, an increase in intramuscular fat content due to altered gestational nutrition could lead to higher value beef carcasses. Altered gestational nutrition has been reported to lead to changes in adiposity, muscle development, growth characteristics, and may alter meat product tenderness of the progeny. Preliminary evidence indicates that the canonical Wnt/beta catenin system, known to increase muscle development, can be affected by gestational nutrition in beef cattle. Recent data has shown PREF-1 can be affected in beef fetal longissimus muscle tissue when dams are provided a diet that exceeds requirements during gestation. These data suggest that increased planes of nutrition may lead to increased differentiation of adipocytes in fetal muscle. Also, decreases in beef tenderness have been reported as a result of gestational under nutrition. Knowledge of these mechanisms could lead to changes in management strategies that produce beef carcasses, and provide opportunities to enhanced marbling, muscling, and tenderness.

Key Words: cattle, fetal programming, muscle, adipose tissue

179 History of amino acid research in lactating dairy cows. D. J. Schingoethe*, *South Dakota State University, Brookings.*

Several classical studies during the 1950s confirmed that the major milk proteins (i.e., caseins, β-lactoglobulin, and α-lactalbumin) were synthesized in the mammary gland from amino acids (AA). Cell culture research in the mid 60s demonstrated the potential to increase milk protein production by presenting more of the essential AA to the mammary gland. Since that time, research efforts by many have contributed to our knowledge of how to best achieve this goal. This presentation summarizes primarily research conducted at South Dakota State University to improve the protein/AA nutrition of lactating cows. Feeding one of the highest quality proteins available, whey protein concentrate which was protected against ruminal degradation with formaldehyde, resulted in one of the highest increases in milk yield observed. Other research since then has aimed to match or exceed those results. Methods employed included: feeding supplemental ruminally protected AA, usually Met with or without Lys; processing methods of protein supplements to increase AA availability for absorption; and formulating diets for improved AA content presented to the digestive tract. Feeding soybean meal subjected to additional heat treatment, either via extrusion or during toasting/desolventizing, increased milk production. Many protein supplements such as from soybeans, sunflower seeds, corn products, canola, whey products, fish meal, blood meal, and their combinations have been evaluated in efforts to improve the AA blend presented to the digestive tract and ultimately to the mammary gland. Several approaches have been used to evaluate AA limitations to milk protein production; how to interpret the uptake and utilization of AA by the mammary gland; and possible methods to evaluate AA limitations to milk protein synthesis. Today there are proposed "models" to formulate diets for AA content. While this is a noteworthy approach, the ruminant's digestive system presents challenges to formulating diets to meet the AA needs of the mammary gland. We don't know all of the answers yet but we are getting closer.

Key Words: amino acids, lactating dairy cows, milk production

180 A review of the ruminally protected amino acid research conducted at South Dakota State University by Dr. Schingoethe. D. P. Casper*, *South Dakota State University, Brookings.*

Several studies were conducted by Dr. Schingoethe along with his students and colleagues focusing on the amino acid requirements of the lactating dairy cow. Many of these studies were continuous long-term studies to measure responses during early and peak lactation. Several studies utilized ruminally-protected methionine in combination with various protein and carbohydrate sources. Feeding ruminally protected methionine in conjunction with soybean meal increased milk production, however no response was observed when cows were fed heat-treated soybean meal or extruded soybeans. However, feeding ruminally-protected methionine did increase milk protein percentages across these 3 protein sources demonstrating that methionine could be a limiting amino acid. Feeding ruminally-protected methionine to an extruded soybean and urea diet that theoretically would be higher in ruminal lysine outflow demonstrated that methionine improved milk protein percentages, but not milk production. Contemporary research at the time demonstrated that barley and soybean meal based diets would have increased intestinal lysine supply were fed with and without ruminally-protected methionine that also demonstrated a response in milk protein percentages. Arterial concentrations of methionine were improved in all studies, except for the barley/soybean meal study, indicating that methionine was being absorbed post-ruminally, thereby increasing blood methionine concentrations. The possible explanation for lack of a blood methionine response on the barley study was a methionine deficiency relative to lysine in that the additional methionine was used for milk protein synthesis, but blood methionine concentrations were similar. These studies demonstrated that methionine can be one of the first limiting amino acids for milk and milk protein production which demonstrated the need for incorporating methionine into nutritional models for balancing diets for lactating dairy cows.

Key Words: amino acids, methionine, lactating dairy cows

181 Factors affecting mammary blood flow (MBF) and its impact on milk production in dairy cows. D. H. Kleinschmit*, *Agri-King Inc., Fulton, IL.*

Increasing the MBF in lactating dairy cows increases milk output because more nutrients should be delivered for absorption and utilization by the mammary gland. In fact, approximately 300 to 800 volumes of blood circulate through the udder per volume of milk produced. Early research found MBF to be highly correlated to milk production, MBF (mg/min) = 1.0 + 0.42 × milk output, kg, r = 0.97. However, one contradicting aspect of MBF is whether mammary metabolism is influenced by MBF or vice-versa. This has not yet been confirmed. Several techniques have been evaluated for evaluating MBF. Specifically, a common, and simple measurement has been the uptake of Phe and Tyr across the mammary gland to predict MBF because they have a 1:1 input:output ratio by the mammary gland. Thus, Phe and Tyr are acceptable predictors of MBF. Past nutrition research has found that dietary fat can decrease milk protein concentration. These results were attributed to a drop in MBF, which decrease amino acid delivery to the mammary gland. The use of rBST has resulted in significant increases in milk yield in both research trials and in the field. Increasing MBF has been attributed to be one of the reasons why these results were observed. Milk production responses have also been observed when cows underwent treatment with thyroxine. In fact, research has demonstrated that the percent increase in MBF to be comparable to the percent milk response observed. Other localized factors in the mammary gland may also be contributors to MBF. A more comprehensive understanding of the factors affecting MBF may be applicable in the field as a tool to help dairy producers optimize milk output.

Key Words: mammary blood flow, milk production, dairy cows

182 Predictions of nutrient availability and animal response of dairy diets based on soy proteins and distillers grains using different formulation models. K. Mjoun*[1] and K. F. Kalscheur[2], *[1]Alltech Inc., Brookings, SD, [2]South Dakota State University, Brookings.*

The nutritive value of diets formulated with DDGS is commonly believed to be underestimated using available dairy models. The accuracy of formulation models to predict nutrient availability and animal response was compared for a traditional diet based on soybean proteins (SP) and a diet based on distillers dried grains with solubles (DDGS) as the primary protein sources. Diets that were evaluated were isonitrogenous and supported similar ECM. Four models were evaluated: NRC (2001), Mepron 3.5.2, CNCPS 6.1.43, and CPM 3.0.10. Evaluations used either nutrient compositions from respective libraries or

actual values for chemical composition including amino acid profiles, protein fractions (RDP, RUP, SP, ADIP, NDIP), and intestinal digestibility of the RUP such that differences in predictions can be primarily explained by mechanisms of digestion and metabolism used in each models. Using library values for feedstuffs, there was considerable variation in nutrient composition among the models, especially in the case of DDGS diets. Protein fractions were considerably different among models regardless of using actual or library values. For duodenal amino acid flow, inter-model estimates were highly variable for most amino acids regardless of the diet. When analyzed values were used, the magnitude of variation was significantly reduced and there was no noticeable difference among models for both diets. Predicted DMI was consistent among models and was lower than that observed. The difference between observed and predicted DMI was twice in DDGS compared with SB diets. Significant differences existed in predicting milk production from ME and MP among models and that MP allowable milk was lower in DDGS compared with SB diet due to Lys limitation. It can be concluded that differences in model predictions can be significant due to inherent assumptions used by specific models and were independent of diets when actual feed values were used

Key Words: formulation models, distillers grains, soybean

183 Field observations of using amino acid balancing for lactating dairy cows: What works and what doesn't. M. Brouk*, *Kansas State University, Manhattan.*

Amino acid balancing has been a major focus of dairy cattle nutrition for the past 3 decades. It resulted in a significant increase in the understanding of nitrogen utilization by dairy cattle. This has resulted in increased milk production, greater efficiency of production and a reduction in nitrogen excretion. However, the field application of amino acid balancing has been and continues to be a challenge. Much of the research conducted to develop the various ration formulation models utilized specific diet ingredients in a controlled environment. However, when application is extended to commercial dairy production, many additional variables are often encountered. Items such as forage quality, cow comfort, level of production, feed management, cattle management, etc. can often reduce the positive impacts of this technology. In addition, dairy rations formulated with a high percentage of by-products may be much different than the diets utilized in the development of the computer models. The net impact of these various factors has been a mixed response to amino acid balancing on commercial dairy operations. While most nutritionists now utilize amino acid balancing in ration formulation, many questions exist due to the varied responses observed. While the emphasis continues to be on lysine and methionine levels and ratios, additional attention is being given to other factors which are much more difficult to measure and quantify. In addition, some have raised the concern that additional amino acids may need to be considered in the overall evaluation of the diet. Development of guidelines that identify the limitations of amino acid balancing on commercial dairies could enhance the benefits of this technology to the industry. This presentation will focus on the practical application of amino acid balancing on commercial dairies and identify some of the concerns and challenges observed in the field.

184 Post-weaning transition ADG can serve as a tool to manage within-barn variation. C. K. Jones* and J. F. Patience, *Iowa State University, Ames.*

Transition ADG (tADG) may be a useful variable to manage barn variation because numerous factors affect successful transition during the weaning process. The objective of this experiment was to evaluate the effects of tADG on growth, nutrient digestibility, and carcass composition of pigs. A total of 1,054 pigs were allocated by sex to one of 40 pens in a commercial wean-to-finish research barn. There were 26 or 27 pigs per pen. Pigs were weighed individually at 0, 3, 6, and 22-weeks post-weaning. Gain from 0 to 3-weeks post-weaning was calculated and termed tADG. Pigs from 3 tADG percentiles were of interest: 10th, 30th, and 70th, which had mean body weights of 6.76, 7.53, and 9.16 kg at 3-weeks post-weaning. At 3-weeks post-weaning, 20 pigs from each of the 3 tADG percentiles (60 total pigs) were harvested to determine whole-body carcass composition, and rectal digesta samples were collected to determine nutrient digestibility. At 22-weeks post-weaning, another 20 pigs from each of the 3 tADG percentiles (60 pigs) were ultrasounded for loin eye area and backfat. Data were analyzed as a CRD using PROC GLIMMIX, where pig served as the experimental unit. There were no sexÃ—tADG interactions ($P > 0.05$). Transition ADG percentile affected all ($P < 0.001$) weight and ADG periods. Of particular interest, pigs from the 10th percentile tADG were nearly 5 kg lighter than pigs from the 70th percentile tADG by wk 6 post-weaning (11.17 vs. 16.00 kg, $P < 0.05$) and nearly 10 kg lighter by wk 22 post-weaning (98.6 vs. 108.6 kg, $P < 0.05$). However, there was no effect of tADG on nutrient digestibility or carcass composition. Sex did not affect ($P > 0.15$) weight or ADG period except ADG from wk 0 to 3 post-weaning ($P = 0.04$). Gilts had larger mean loin eye area compared with barrows (46.8 vs. 42.6 cm2, $P = 0.001$), but there were no other effects of sex on carcass composition or nutrient digestibility. These data underscore the impact of tADG on subsequent pig performance and suggest that this variable may be a valuable tool to manage within-barn variation.

Key Words: nutrient digestibility, pig, transition, variation

185 Effect of Liquitein on nursery pig performance when administered via the water for 2 days post-weaning. R. S. Fry*, S. B. Williams, N. D. Paton, and D. R. Cook, *Provimi North America, Akey Nutrition and Research Center, Lewisburg, OH.*

Eighteen hundred and forty barrows and gilts (PIC genetics) weaned at approximately 19 d of age were utilized to determine the effect of Liquitein (TechMix, LLC) on nursery pig performance. Within each of 2 barns pigs were sorted into light (5.3 ± 0.35 kg) and heavy (6.7 ± 0.35 kg) BW in a split-plot design. Pigs were fed a 3 phase program for 41 d and pens (23 pigs/pen) were randomly allocated to dietary treatments. Phase 1 dietary treatments consisted of 1) a negative control (NC) diet without plasma, 2) a positive control (PC) diet with 3.5% plasma, 3) a PC diet + Liquitein administered via the water at a 1:128 dilution and 4) a PC diet + Liquitein administered via the water at a 1:50 dilution. Liquitein was administered for only 2 d post-weaning. Following phase 1, all pigs received a common diet and pigs had ad libitum access to feed and water during all phases. Pen weights and feed intakes were obtained at the end of each phase. There were no interactions between BW and dietary treatment, thus only main effects will be discussed. Average daily gain, ADFI, and final BW were greater ($P < 0.01$) for heavy vs. light pigs. Phase 1 ADG tended ($P < 0.10$) to be greater in PC vs. NC pigs. Liquitein pigs, regardless of dose, had greater ($P < 0.01$) ADG than PC pigs. Furthermore, ADFI was greater ($P < 0.01$) in Liquitein vs. PC pigs, but also tended ($P < 0.10$) to be greater in pigs administered 1:50 vs. 1:128 Liquitein. Pigs receiving Liquitein were heavier ($P < 0.05$) at the end of phase 1 compared with PC pigs. Phase 2 ADG and BW were not affected by dietary treatment. However, previously providing Liquitein, regardless of dose, tended ($P < 0.10$) to increase ADFI and reduce G:F when compared with PC pigs. Phase 3 BW tended ($P < 0.10$) to be greater for Liquitein vs. PC pigs, but was not affected by dose. Administering Liquitein for 2 d post-weaning did not affect overall ADG, ADFI, or G:F, but tended ($P < 0.10$) to increase final BW when compared with the PC pigs (24.4 vs. 24.0 kg).

Key Words: pig, Liquitein, plasma

186 Effect of phytase source and level to improve nursery pig performance fed corn-soybean meal based diets in a commercial environment. D. D. Hall*[1], M. U. Steidinger[2], J. C. Remus[3], T. D. Parrott[3], and A. J. Veldkamp[3], *[1]Hall Farms Consulting LLC, Noblesville, IN, [2]Swine Nutrition Services, Afton, IL, [3]Danisco Animal Nutrition, Waukesha, WI.*

An experiment was conducted to test a hypothesis that dietary supplementation of phytase [Danisco Phyzyme XP G TM from *S. pombi* (SP) or DSM Ronozyme P-M TM from *P. lycii* (PL)] at 2 levels of phytase addition (1,000 and 2,000 units/kg) improves nursery pig performance. Pigs were fed simple corn-soybean meal based diets with adequate phosphorus(P) levels in the diet. Rations were formulated to be in excess of NRC (1998) requirements for all nutrients including P. Mono-calcium phosphate was added to all diets to achieve 0.50% available P from d 0–21 and 0.40% available P from d 21–40. Phytase sources were added on top of adequate P, control diets to test the theory that phytate in corn-soybean meal diets has a negative impact on pig performance that can be alleviated by phytase addition to the diet. Dietary phytate P was estimated to be 0.21–0.25% from corn and soybean meal ingredients in all diets. Pigs (n = 1085) were housed at 30–32 pigs/pen. The trial consisted of 7 replications (initial wt. 5.9 kg). Allocation and statistical analysis (SAS.JMP) was block design with block = (rep. initial wt.). SP resulted in improved daily gain from d0–21 ($P < 0.05$) in nursery pigs compared with pigs fed PL (Table 1). The increased daily gain resulted in 0.44 kg heavier pigs at d21 on trial in pigs fed SP vs. PL phytase (11.95 vs. 11.51 kg; $P < 0.08$). There were no differences in daily gain, feed intake or gain/feed from d 21–40 on trial. SP phytase improved early nursery pig performance by reducing the negative impact of phytate, but not all phytase sources appear to provide this benefit.

Table 1.

Phytase u/kg	Control 0	Danisco SP 1000	Danisco SP 2000	DSM PL 1000	DSM PL 2000	SEM	Phytase Source *P*<
D 0-21 ADG, kg/d	0.276	0.284	0.289	0.268	0.263	0.009	0.05
ADFI, kg/d	0.392	0.401	0.404	0.383	0.380	0.012	0.15
Gain/Feed	0.705	0.710	0.715	0.699	0.694	0.011	0.24
D 21 Wt. kg	11.72	11.88	12.01	11.57	11.44	0.217	0.08
D21-40 ADG, kg/d	0.587	0.585	0.591	0.588	0.582	0.012	0.84
ADFI, kg/d	0.951	0.949	0.966	0.953	0.937	0.024	0.66
Gain/Feed	0.618	0.617	0.614	0.618	0.621	0.007	0.64
D 40 Wt, kg	22.90	23.09	23.30	22.71	22.49	0.388	0.19

Key Words: phytase, pigs, nursery

187 Effect of lipid source and oxidation level on metabolic oxidation status of young pigs. P. Liu*[1], B. J. Kerr[2], T. E. Weber[2], C. Chen[1], L. J. Johnston[1,3], and G. C. Shurson[1], *[1]University of Minnesota, St. Paul, [2]USDA-ARS, Ames, IA, [3]West Central Research and Outreach Center, Morris, MN.*

To evaluate effect of lipid source and oxidation level on metabolic oxidation status of young pigs, 108 barrows (6.66 kg BW) were assigned to dietary treatments in a 4 × 3 factorial design plus a corn-soybean meal control diet. Main effects were lipid source [corn oil (CN), canola oil (CA), poultry fat (PF), and tallow (TL)] and oxidation level [original lipids (OL), slow oxidation (SO) of lipids heated for 72 h at 95°C, or rapid oxidation of lipids (RO) heated for 7 h at 185°C]. Pigs were fed ad libitum for 28 d, followed by controlled feed intake (4% BW) for 10 d. Dietary levels of vitamin E were 11 and 12.2 IU/kg for lipid and control diets, respectively. On d-38, serum after a 24 h fast was collected for α-tocopherol (α-T) and thiobarbituric acid reactive substances (TBARS) analysis. Slow oxidation increased ($P < 0.01$) PV compared with OL and RO in all lipids (119 vs. 1 and 4.8 $mEqO_2$/kg, respectively). Both SO and RO had higher ($P < 0.01$) TBARS than OL (567 and 370 vs. 31 μmol/kg, respectively) in CA and CN. Slow oxidation and RO caused 4-hydroxynonenal (HNE) generation in CN (194 and 594 mmol/kg, respectively), CA (105 and 221 mmol/kg, respectively) and TL (13 and 6 mmol/kg, respectively), while only SO produced HNE in PF (2 mmol/kg). Lipid SO and RO decreased ($P < 0.05$) serum α-T levels of pigs fed CA and CN, but not in PF and TL treatments. Pigs fed CA or CN diets increased ($P < 0.05$) serum α-T levels than those fed PF (1.25 or 1.41 vs. 0.89 μg/mL, respectively). Serum α-T levels of pigs fed CN tended to be higher ($P = 0.07$) than those fed TL (1.41 vs. 1.11 μg/mL, respectively). Pigs fed SO or RO had lower ($P < 0.05$) serum α-T levels than those fed OL (0.91 or 0.59 vs. 1.73 μg/mL, respectively). Feeding CN or CA had higher ($P < 0.05$) serum TBARS than feeding PF or TL diets, and feeding SO or RO increased ($P < 0.05$) serum TBARS compared with feeding OL. In conclusion, feeding weaning pigs diets containing 10% of thermally oxidized animal fats and vegetable oils for 38 d impairs their oxidative status by reducing serum α-T and increasing serum TBARS.

Key Words: lipid source, lipid oxidation, metabolic oxidation status, young pigs

188 Effect of low dietary micromineral levels fed to grower-finisher pigs on growth, carcass characteristics and meat quality. D. W. Gowanlock*[1], D. C. Mahan[1], J. S. Jolliff[1], and G. M. Hill[2], *[1]The Ohio State University, Columbus, [2]Michigan State University, East Lansing.*

Dicalcium phosphate and limestone as well as the innate microminerals in the dietary grains provide appreciable amounts of essential microminerals. When a corn-SBM diet is formulated with these macromineral sources, the innate micromineral concentration of the diet may meet many of the dietary needs of grower- finisher pigs, but their bioavailability is unknown. An experiment examined the effects of removing the trace-mineral (TM) premix on growth performance, carcass characteristics and meat quality. This experiment was a RCB design conducted in 5 replicates. The 6 treatments evaluated were: 1) negative control (NC) with no added TM, 2) NC + 25 ppm Zn, 3) NC+ 50 ppm Zn, 4) NC + 50 ppm Fe, 5) NC + 50% NRC (added Cu = 2 ppm; Fe = 25 ppm; Mn = 1 ppm and Zn = 25 ppm, and 6) NC + 100% NRC microminerals. All diets incorporated organic Se at 0.3 mg/kg. Grower pigs, (n = 162) initially weighing 25 kg BW were allotted to treatments based on BW, sex, and ancestry. While in the nursary, pigs were fed diets that met or exceeded NRC requirements. At 55, 80 and 120 kg BW, 3 pigs per pen were bled for hemoglobin and hematocrit determination. At 120 kg BW, 3 pigs per pen were slaughtered and carcass characteristics and muscle quality (color and drip loss) measured. The overall ADG for the treatments were: 1.10, 1.11, 1.11, 1.10, 1.10 and 1.11 kg/ d, respectively ($P > 0.10$) with no differences in ADFI ($P > 0.05$) and G: F ($P > 0.10$) during the overall grower-finisher period. Hemoglobin and hematocrit values also did not differ ($P > 0.10$) during the grower-finisher period. Backfat at the 10th rib and LMA as well as loin L*, a*, b*, and drip loss showed no differences ($P > 0.10$) between treatments. These results indicate that during the grower-finisher phase, micromineral supplements can be reduced without any deleterious effects on performance, hematology, and muscle or carcass quality.

Key Words: carcass, microminerals, muscle, pig

189 Effect of trace mineral supplementation on metallothionein protein and antioxidant enzyme activity in grow-finish pigs. G. M. Hill*[1], J. E. Link[1], D. C. Mahan[2], D. W. Gowanlock[2], and J. S. Jolliff[2], *[1]Michigan State University, E. Lansing, [2]The Ohio State University, Columbus.*

Trace mineral requirements of today′s pigs have not been evaluated yet, nutrient waste and cost can be reduced if the requirement of the animal is not exceeded. Therefore, our objective was to determine if the grow-finish pigs′ trace mineral needs for metallothionein protein and antioxidant enzyme activity could be met with reduced trace mineral supplementation. The treatments were: 1) 0 ppm trace minerals; 2) 25 ppm organic Zn; 3) 50 ppm organic Zn; 4) 50 ppm organic Fe; 5) 50% NRC trace minerals (organic); or 6) 100% NRC trace minerals (organic) added to a corn-soybean meal basal diet with no added TM but supplemented with Se, Ca, and P to meet NRC requirements. At 25 kg BW 162 pigs were allotted in RCBD to treatments (5 or 6 pigs/pen) based on sex, weight and litter; 3 dietary phases were fed with ractopomine (9 g/909 kg) added during the last 3 wk. Twelve pigs/treatment were killed at approximately 117 kg. Duodenum and jejunum mucosa scrapings and liver were collected for determination of Mt; hepatic Cu/Zn superoxide dismutase (Cu/Zn SOD), Mn SOD and glutathione peroxidase (GSH-Px) activities were analyzed. The Mt protein concentrations in duodenum and jejunum did not differ, but hepatic Mt was greatest in pigs fed 25 ppm Zn or 50% NRC ($P = 0.02$). The Cu/Zn SOD activity did not differ by treatment, but hepatic MnSOD was less in pigs fed 25 ppm Zn vs. 50% NRC (3.3 vs. 4.1 units/mg protein, respectively; $P = 0.03$). Since Se was supplemented in all treatment diets, GSH-Px did not differ among treatments ($P = 0.28$). Gilts had less duodenal Mt than barrows (32.5 vs. 43.6 EU/mg protein, respectively; $P = 0.01$); a similar pattern was observed for jejunal Mt (11.8 vs. 15.2, $P = 0.0002$). These parameters indicate that trace element supplementation at NRC (1998) recommendations may not be necessary for grow-finish pigs fed a corn-soybean meal diet supplemented with Ca, P, and Se.

Key Words: grow-finish swine, trace minerals, zinc

190 Evaluation of a superdose of a novel *Escherichia coli* phytase and zinc in piglets. C. L. Walk*[1], S. Srinongkote[2], and P. Wilcock[1], *[1]AB Vista Feed Ingredients, Marlborough, Wiltshire, UK, [2]Bangkok Animal Research Center, Bangkok, Thailand.*

The anti-nutrient phytate may negatively influence piglet growth performance. Phytase may alleviate the influence of phytate on piglet performance by breaking down phytate. Zinc is commonly added to piglet diets to improve growth performance and prevent diarrhea. However, the beneficial effects of supplemental Zn when combined with phytase are inconsistent. An experiment was conducted to evaluate a superdose of a novel *E. coli* phytase (AB Vista, UK; 0 or 2,500 FTU/kg) and 3 levels of supplemental Zn (0, 1,750, or 3,500 ppm) on piglet growth performance and serum Ca, P, and Zn. Piglets (n = 288; 7 kg), were allowed ad libitum access to one of 6 dietary treatments (6 pens per treatment) from d 0 to 42 post-weaning. Calcium and available P was formulated to meet or exceed NRC requirements in all feeding phases. Diets were arranged as a 2 × 3 factorial and consisted of low zinc (LZ; 112 ppm Zn from premix), LZ + 2,500 FTU/kg phytase, medium zinc (MZ; 1,750 ppm Zn from ZnO), MZ + 2,500 FTU/kg phytase, high zinc (HZ; 3,500 ppm Zn from ZnO), and HZ + 2,500 FTU/kg phytase. From d 0 to 21, average daily feed intake (ADFI), average daily gain (ADG), and feed conversion were not affected by Zn or a Zn x phytase interaction. Phytase increased ($P < 0.05$) ADFI and ADG compared with piglets fed non-phytase supplemented diets. Serum Ca was increased ($P < 0.05$) in piglets fed LZ + 2,500 FTU/kg phytase compared with piglets fed all other treatments, except piglets fed HZ without phytase, which resulted in a Zn x phytase interaction ($P < 0.05$). Serum P decreased and serum Zn increased linearly ($P < 0.05$) in piglets fed supplemental Zn. Phytase increased ($P < 0.05$) serum P and serum Zn. From d 0 to 42, phytase increased ($P < 0.05$) ADG compared with piglets fed non-phytase supplemented diets. Serum Ca linearly ($P < 0.05$) decreased and serum Zn linearly ($P < 0.05$) increased with dietary Zn supplementation. In conclusion, phytase improved piglet growth performance regardless of the inclusion of supplemental Zn. Serum analysis suggests phytase improved P and Zn absorption in P adequate diets by breaking down phytate and alleviating the formation of insoluble phytate-P-Zn complexes.

Key Words: phytase, piglet, zinc

191 The effects of organic zinc, zinc sulfate, and zinc oxide on nursery pig performance. J. S. Jolliff*[1], D. C. Mahan[1], J. L. Pierce[2],

B. W. James[3], and G. M. Hill[4], *[1]The Ohio State University, Columbus, [2]Alltech Inc., Nicholasville, KY, [3]Kalmbach Feeds Inc., Upper Sandusky, OH, [4]Michigan State University, East Lansing.*

There are several sources of Zn (organic, Zn sulfate and ZnO) being used in pig starter diets. We evaluated their relationship over a 42 d postweaning period. Diets were complex, were provided in 3 phases, and met the NRC requirements for all nutrients except Zn. Exp. 1 evaluated dietary organic Zn (Alltech Inc.) and ZnO. Pigs (n = 488; BW = 5.8 kg) were allotted to a 3 × 2 + 1 arrangement (9 reps/treatment). Treatment 1 was a negative control (no added Zn), while treatments 2 to 4 contained added organic Zn at 25, 50, and 75 mg/kg. Treatments 5 to 7 were the same as treatments 2 to 4 except that 3000 ppm ZnO was also added during the initial 21 d postweaning. Performance was unaffected by treatment from 0 to 7 d. From 7 to 21 d, ADG ($P < 0.01$), and ADFI ($P < 0.01$) increased as the level organic Zn increased with a further increase to ZnO ($P < 0.01$). From 21 to 42 d, organic Zn continued to increase ADG ($P < 0.01$), but pigs that had received ZnO for the initial 21 d had lower ADG ($P < 0.01$) and G:F ($P < 0.05$) than the other treatments. Over the 42 d period, ADG increased with increasing levels of organic Zn ($P < 0.01$) with no net effect of ZnO. In Exp. 2, pigs (n = 357; BW = 5.8 kg) were allotted to a 2 × 2 arrangement (9 reps/treatment) with 2 levels of dietary Zn sulfate (0, 75 mg/kg) and 2 levels of ZnO (0, 3000 ppm). ZnO was fed for only the first 21 d. From 0 to 7 d, ZnO reduced ($P < 0.05$) ADFI. From 7 to 21 d, Zn sulfate increased ADG ($P < 0.01$) and ADFI ($P < 0.01$) while ZnO increased G:F ($P < 0.05$). The benefits of Zn sulfate were greater when ZnO was added to the diet (interaction; $P < 0.05$). ZnO treatment reduced ($P < 0.05$) performance 21 to 42 d period, but did not affect performance from 0 to 42 d. In conclusion, ADG increased with increasing levels of organic Zn to 75 ppm. Pigs fed 3000 ppm ZnO had increased performance from 7 to 21 d, but had reduced performance from 21 to 42 d in both experiments.

Key Words: pig, weaning, zinc

192 Development of a model simulating the metabolic fate of dietary phosphorus and calcium in growing pigs. M. P. Létourneau-Montminy*[1], A. Narcy[2], and C. Pomar[1], *[1]Agriculture and Agri-Food Canada, Sherbrooke, Quebec, Canada, [2]INRA UR-83, Nouzilly, France.*

Optimizing phosphorus (P) utilization in pigs relies on our capacity to predict P requirements and the amount of dietary P that can be absorbed and is available for the retention. These require to quantify the impact of the main modulating factors implicated in P utilization, which are dietary P forms and amounts, calcium (Ca) supply, bone growth potential and animal mineral status. This study is part of an ongoing program developing a robust mechanistic model predicting P and Ca utilization by pigs in a large range of dietary situations (e.g., with varying levels of phosphates, phytase and DDGS supply). The first step is to predict the amount of dietary Ca and P required to achieve optimal bone mineralization and to simulate the impact of dietary Ca and P imbalances. The gastro-intestinal tract, extracellular fluids, soft tissues (protein, lipid) and bone are the model compartments. Soft tissue growth is predicted using InraPorc model to which mineral states and flows had been integrated. Body mineral potential and retention is driven in this model independently of body protein mass and retention. The model behavior is consistent, predicting increased P absorption, excretion, and retention flows while P concentration in soft tissue remains fairly constant in non-limiting dietary Ca conditions for bone mineral deposition. Compared with literature data, total body P, Ca, and protein accretion is also accurately estimated (e.g., For P, Y = 2.79 + 0.996x; Relative Mean square prediction error (rMSPE) = 6.7%; error of disturbance (ED) = 99.4%; For Ca, Y = −23.9 + 1.05x; rMSPE = 8.9%; ED = 94.2%). According to this model, P urinary losses rapidly increase when dietary Ca and P are supplied over the pig capacity to retain these minerals but also when Ca is supplied under required levels. This model helps to formulate P and Ca balanced diets with traditional or unconventional feed ingredients and represents an essential tool to ensure optimal growth performance, animal welfare, product quality, and environment protection.

Key Words: phosphorus, modeling, pigs

Nutritional and Non-Nutritional Influences on Pork Quality Attributes

193 Extrinsic and intrinsic factors that influence and dictate adipose tissue deposition in pigs. G. J. Hausman*, *USDA-ARS-RRC, Athens, GA.*

Reduction of adipose tissue accretion in the growing pig has been successful and has contributed to a decisive improvement in pig production. The substantial number of factors that constitute and influence porcine adipose tissue accretion will be reviewed in this paper. Gradients of vascular structure development dictate blood flow and the cellular development of adipose tissue in fetal and growing pigs. As the fetus develops, several layers of subcutaneous adipose tissue (outer, middle, inner) become apparent. Each of these layers continues to grow and expand postnatally in a manner such that fetal subcutaneous layer development is predictive of the degree of fat cell development in each layer postnatally. The cellular development of adipose tissue in growing pigs is location or depot and species dependent with adipocytes in internal depots generally the largest compared with adipocytes in the subcutaneous and intramuscular depots. Considerable information on the various adipose depots gathered over the years indicates the significance and impact of anatomical location on cellular development and metabolism. The individual backfat layers in pigs are highly heritable and are similarly genetically correlated with intramuscular fat. The long-term selection for leanness not only has decreased backfat accretion but has decreased intramuscular adipose tissue while increasing muscle mass. Intermuscular adipose tissue development is distinct for several reasons. For instance, the development of this depot is determined before 20 kg of body weight. Selection for increased carcass leanness appears to be less successful for reducing intermuscular adipose tissue versus subcutaneous adipose tissue. Other aspects of location or depot influence on pig fat accretion will also be reviewed.

194 Nutritional influences on fat quality of pork products. J. L. Johnston*[1] and X. Li[2], *[1]University of Minnesota, West Central Research and Outreach Center, Morris, [2]University of Minnesota, St. Paul.*

For years, scientists have known that dietary fat influences the character and quality of pork fat. This relationship has not been the subject of much concern until recently when economic factors began driving high concentrations of alternative ingredients into diets for pigs. Of particular concern is the high concentration of distillers dried grains with solubles (DDGS) included in swine diets. Very high dietary inclusion rates (30 to 50%) of DDGS increases intake of unsaturated fatty acids from corn oil which decreases firmness of carcass fat. As dietary DDGS concentration increases, unsaturation and softness of carcass fat increases linearly. Dietary influences on carcass fat quality are exacerbated in high-lean pigs that dominate modern production systems compared with fatter pigs produced in the past. Current economic considerations favor continued use of high levels of dietary DDGS for the near future. Dietary approaches need to be employed that allow continued use of DDGS while mitigating negative effects on pork fat quality. Formulation of diets based on Iodine Value Product has potential to control soft fat in pork carcasses but requires refinements to be consistently effective. Total withdrawal or reducing DDGS in diets at least 3 wk before harvest improves fat quality but cost savings accrued by using DDGS are relinquished at a time when pigs are consuming the greatest quantity of feed. Early studies of corn-soybean meal based diets suggest that dietary crude glycerol (8%) can improve belly firmness but these results need to be confirmed with diets high in DDGS. Dietary conjugated linoleic acid (CLA) increases the saturated:unsaturated fatty acid ratio and decreases iodine value of carcass fat by depressing desaturase enzyme activity. Unfortunately, CLA is expensive and presents challenges with effective implementation under commercial conditions. Other metabolic modifiers of adipose tissue may prove effective in improving fat quality of pigs fed high levels of unsaturated fatty acids present in alternative feed ingredients. Nutritional approaches are available to partially mitigate problems with pork fat quality but implementation will depend on economic pressures faced by pork producers.

Key Words: pork, fat quality, soft fat, pigs

195 Practical implications of diet formulation and swine management on pork carcass fat composition. J. A. Hansen*[1] and D. C. Kendall[2], *[1]Murphy-Brown LLC, Rose Hill, NC, [2]Prestage Farms Inc., Clinton, NC.*

Meat processors expend considerable effort attempting to characterize, monitor, report and sometimes compensate pork producers for pork fat quality. Defining pork fat quality is difficult at best, often characterized by simple measures of degree of fat saturation such as iodine value, or more practically characterized through physical measures such as belly flop. It is fair to conclude that there is no single good or accurate measure of pork fat quality today that provides guidance to the producer as to the source of any given problem. The source of pork carcass fat quality problems can typically be related to either composition of growth and(or) diet composition factors. It is well recognized that diet composition can and will influence the composition of carcass fat. Such an effect can be summarized by the statement, "the more fat you feed a pig, the more the pig carcass looks like the fat it was fed." Unfortunately, most fats of plant origin in typical swine diets are highly unsaturated, imparting a soft and oily outcome on the carcass. Dietary effects alone do not explain all of the variance observed in the packing plant. Indeed, de novo fat synthesis is an important component contributing to carcass fat quality, in turn, rate of growth is a primary driver of de novo synthesis. Animals harvested from environments in which growth rate was restricted demonstrate a lack of fat cell fill and cellular immaturity that ultimately lead to thin pork bellies, fat:muscle layer separation and other undesirable outcomes in both fresh and processed meats. Genetic selection is no less important than growth rate when it comes to de novo fat synthesis, lean lines tend to create more concern than fat lines for all the same reasons. Increasing sale weight often leads to more total de novo fat synthesis as the animal gets closer to physiological maturity. Establishing a framework for constructive feedback and/or premiums associated with enhanced pork fat quality will be necessary to drive greater value and understanding through the production and processing chain.

196 How will the consumer of today and tomorrow define pork quality? S. J. Moeller*, D. D. Boler, and H. N. Zerby, *The Ohio State University, Columbus.*

A primary challenge facing the production, meat packing, and processing sides of the pork industry is defining how the consumer (re) defines the term quality and follows that definition in their purchasing

decisions. A large number of studies across the globe have addressed this question from not only a pork perspective, but also a general protein perspective, as red-meat and poultry industry interests compete for their share of the consumers' dollar. Ultimately, the consumer dollar drives change in the industry: this change may be related to improving palatability, enhancing convenience, or maintaining a nutritious, wholesome product. Currently, US per capita pork consumption is relatively flat, thus, it must be recognized that the economic drivers and opportunities for the pork industry also include the shear increase in the global population and the increasing strength of the export market. To increase pork consumption, the industry will need to produce pork products that are palatable, healthful, wholesome, and cost effective within the constraints of the consumer's income for both domestic and international markets. In fact, a 2011 survey (Simmons, Elanco Animal Health, AI11192 (03/11)) of consumers rated taste (43.5%) and cost (31.5%) as the 2 most important factors in their food purchasing decisions. Research indicates that consumers respond very favorably to improved tenderness in loin and that enhancement of loins with a salt-phosphate solution has an additive effect on the tenderness achieved and the overall acceptability and palatability of the loin. However, traditional, often highly inter-related measures of quality, including pH, water-holding capacity, and intramuscular fat have also been described to influence palatability and likely should not be ignored in the face of enhancement and or targeting product characteristics to consumer demands across market segments. Quality, in the face of a fundamental shift in feedstuffs available and used, and a genetic base that is very lean and continually being selected for improved efficiency, now more than ever the industry must be focused on enhancing the value of the entire carcass. Consumers of the future will expect quality and palatability improvements in all cuts of pork, including the belly (fat and lean) as we produce and market high-value bacon, the ham (marketing individual muscles) including new, non-traditional processing methods, and the shoulder as consumers seek sausage-type products that have less fat and sodium. In the future, consumers will likely define quality as a combination of safe, healthful, highly palatable, and affordable pork. Safe and healthful pork will require new, innovative approaches to enhancement (salt levels, binders, non-meat ingredients, etc.). New products will continue to be developed to meet the demands of consumer's changing lifestyles. Affordability will play out in continued sorting and product differentiation, while palatability expectations will continue to exist and may become more focused on the volume-based cuts such as the ham and shoulder. A key will be the ability to offer acceptable value in a product that meets consumer's taste expectations.

197 Effect of β-carotene supplementation on plasma vitamin A, growth, performance, and carcass characteristics of feedlot cattle. K. N. Condron*, R. P. Lemenager, M. C. Claeys, and J. P. Schoonmaker, *Purdue University, West Lafayette, IN.*

One-hundred forty Angus × Simmental crossbred calves were allotted by BW (351.3 ± 12.1 kg) and sex (19 steers, 9 heifers per treatment) to 5 treatments (6 pens per treatment) to evaluate the effects of vitamin A (VA) form on performance and carcass characteristics. Treatments consisted of retinyl palmitate (RP) supplemented at the NRC VA requirement (2200 IU/kg), synthetic β-carotene (βC, all-*trans* isomer) supplemented at 1×, 5×, or 10× the NRC VA requirement, and natural βC (50/50 mix of all-*trans* and 9-*cis*-βC) supplemented at 5× the NRC VA requirement. The 1× βC did not change plasma concentrations of RP, βC, or other carotenoids ($P > 0.26$) compared with RP. Increasing dietary βC increased ($P < 0.04$) plasma concentrations of RP as well as the all-*trans*, 9-*cis*, 13-*cis*, and 15-*cis* isomers of βC. Natural βC decreased ($P < 0.04$) plasma concentrations of RP, all-trans-βC, and 13-*cis*-βC, and increased ($P < 0.01$) α-carotene when compared with 5× βC. Form of VA did not impact BW or ADG ($P > 0.35$), however, βC tended ($P < 0.10$) to have a quadratic effect on overall daily DMI, with a decrease from 1× to 5× and an increase from 5× to 10×. Marbling and fat thickness were not affected by form of VA ($P > 0.35$), however, increasing concentration of βC tended ($P < 0.10$) to linearly increase LM area while natural βC tended ($P < 0.10$) to decrease LM area compared with 5× βC. Liver weights were increased in animals fed 1× βC compared with animals fed RP ($P < 0.10$). L* values of LM decreased linearly in response to βC supplementation ($P < 0.05$) and b* values of subcutaneous fat responded quadratically to βC supplementation ($P < 0.05$), with an increase from 1× to 5× and a decrease from 5× to 10×. Using synthetic βC instead of RP does not negatively affect fat deposition; however, increasing dietary concentrations of βC alters the yellow color of fat and tends to increase LM area. Natural βC does not appear to have any benefits over synthetic βC.

Key Words: beef cattle, vitamin A, beta-carotene, carcass quality

198 Use of a complete-feed diet (RAMP) in grain adaptation programs compared to traditional grain adaptation programs. C. J. Schneider*, B. L. Nuttelman, K. M. Rolfe, W. A. Griffin, T. K. Klopfenstein, and G. E. Erickson, *University of Nebraska, Lincoln.*

A study evaluated using RAMP to adapt cattle to a high grain finishing diet. Yearling crossbred steers (n = 229; BW = 397 ± 28.4 kg) were consecutively weighed over 2 d, stratified by BW, and assigned randomly within strata to 18 feedlot pens, with 12 or 13 steers per pen. Treatments were imposed during grain adaptation (22 d) by decreasing RAMP (100 to 0%) and increasing finishing diet (0 to 100%). RAMP was fed either as a blend in a 1-diet system which was delivered twice daily (RAMP-1RS) or as 2 daily diets where RAMP was delivered in one feeding and finisher was delivered in another feeding (RAMP-2RS). The control treatment (CON) was a traditional adaptation program with alfalfa hay inclusion decreasing (45 to 7.5%) while corn grain inclusion increased. Adaptation steps for RAMP-2RS were 4 d for first diet and 3 d for the 6 subsequent diets, with RAMP delivered as the first feeding during steps 1, 2, and 3 and the finisher as the first feeding during steps 4, 5, 6, and 7. Adaptation steps for RAMP-1RS and CON were 4, 6, 6, and 6 d for steps 1, 2, 3, and 4, respectively. On d 23 through the remainder of the finishing period, cattle were fed a common diet. Treatments RAMP-1RS and RAMP-2RS tended ($P < 0.09$) to decrease DMI during the adaptation period compared with CON. Daily gain and G:F were similar ($P > 0.50$) among treatments during the grain adaptation period. Over the entire feeding period RAMP-1RS and RAMP-2RS increased ($P < 0.01$) G:F compared with cattle adapted using CON (0.142, 0.141, and 0.131, respectively). Feeding RAMP-1RS increased ADG ($P = 0.03$) compared with CON. Intakes were similar ($P = 0.39$) among treatments. Feeding RAMP tended to increase ($P = 0.13$) HCW, no other carcass traits were affected ($P > 0.4$) by adaptation method. Using RAMP is a viable alternative to traditional adaptation and led to improved feed efficiency in this study regardless of whether it was delivered with the finishing diet as a blend or in 2 daily diets.

Key Words: beef cattle, feedlot, grain adaptation

199 Use of a complete-feed diet (RAMP) to rapidly transition cattle to a finishing diet. C. J. Schneider*, B. L. Nuttelman, D.B. Burken, T. J. Klopfenstein, and G. E. Erickson, *University of Nebraska, Lincoln.*

A study evaluated transitioning cattle from RAMP to a finishing diet with fewer intermediate step diets and days fed during transition. Yearling crossbred steers (n = 390; BW = 341 ± 14 kg) were blocked and stratified by BW, and assigned randomly within strata to 40 feedlot pens, with 9 or 10 steers per pen. Treatments were different grain adaptation programs (27 or 28 d) involving blends of RAMP and finishing diet. A control adaptation program involved decreasing RAMP and increasing a 62.5% corn finishing diet (62.5% high moisture corn (HMC), 25% sweet bran, 7.5% alfalfa hay (AH), and 5% dry supplement) in 5 steps (100:0, 75:25, 50:50, 25:75, and 0:100 RAMP to finishing diet) fed for 4, 6, 6, 6, and 6 d, respectfully (CON62.5). Four remaining adaptation programs involved decreasing RAMP and increasing inclusion of a 40% corn finishing diet (40% HMC, 47.5% sweet bran, 7.5% AH, and 5% dry supplement). Two programs consisted of 5 steps (100:0, 75:25, 50:50, 25:75, and 0:100 RAMP to finishing diet), fed for either 4, 6, 6, 6, and 6 d (CON40) or 10, 1, 1, 1 and 14 d (3–1d), The final 2 programs consisted of 4-steps (100:0, 67:32, 32:67 and 0:100 RAMP to finishing diet) fed for 10, 2, 2, 14 d (2–2d) or 3-steps (100:0, 50:50, and 0:100 RAMP to finishing diet) fed for 10, 4, and 14 d (1–4d). Following adaptation, a common finishing diet (40% HMC, 25% sweet bran, 22.5% modified distillers grains with solubles, 7.5% AH, and 5% dry supplement) was fed for the remainder of the feeding period. Adaptation program did not affect DMI ($P > 0.2$) during the adaptation period or over the entire feeding period. Daily gain and G:F were similar ($P > 0.7$) among treatments with G:F of 0.179, 0.182, 0.179, 0.182, 0.181 for CON62.5, CON40, 3–1d, 2–2d, and 1–4d, respectively. Carcass traits were not affected ($P > 0.1$) by adaptation method. Cattle started on RAMP can transition to a finishing ration containing 47.5% sweet bran in fewer days with fewer step diets than traditional grain adaptation programs without negatively affecting performance.

Key Words: beef cattle, feedlot, grain adaptation

200 Using beet pulp to adapt cattle to finishing diets compared to traditional grain adaptation with alfalfa hay. C. J. Schneider*, M. K. Luebbe, K. H. Jenkins, S. A. Furman, G. E. Erickson, and T. J. Klopfenstein, *University of Nebraska, Lincoln.*

A study was conducted to compare grain adaptation programs using beet pulp (BP) to traditional grain adaptation with alfalfa hay (AH). Yearling crossbred steers (n = 232; BW = 326 ± 14.5 kg) were separated into 3 weight blocks, stratified by BW, and assigned randomly, within strata, to 18 feedlot pens, with 12 or 13 steers per pen. Treatments were imposed during grain adaptation (21 d) using 3 grain adaptation programs. Within each grain adaptation program, 4 step rations were fed for 3, 4, 7, and 7 d. Each program increased dry-rolled corn inclusion while roughage inclusion decreased. In the control treatment (CON), AH inclusion decreased from 46 to 6% and pressed BP (24% DM) was held constant at 6% in all step rations. Beet pulp adaptation programs included a low BP treatment (LOBP) where BP was decreased from 18 to 6% and AH from 34 to 6% or a high BP treatment (HIBP) in which both BP and AH were decreased from 26 to 6%. On d 22 through the remainder of the finishing period cattle were fed a common diet (62% dry rolled corn, 20% wet distillers grains with solubles, 6% AH, 6% BP, 0.25% urea, and 5.75% liquid supplement DM basis). During grain adaptation, cattle fed CON tended ($P = 0.07$ for overall F test, $P = 0.02$ for mean comparison) to have greater DMI than HIPB and LOPB was intermediate (9.9, 9.5, and 9.7 kg, respectively). Gain and G:F were not different ($P > 0.19$) among treatments during the grain adaptation period. However, based off of carcass adjusted final BW, steers adapted using HIBP and LOBP tended ($P = 0.07$ for overall F-test, $P = 0.04$ for mean comparison) to have greater ADG compared with CON (1.65, 1.72, and 1.73 kg, respectively). Overall G:F was not different ($P = 0.11$) among treatments. Dry matter intakes were not different across all treatments ($P = 0.58$). Carcass characteristics were not affected by adaptation method ($P > 0.31$). Replacing up to 50% of AH with BP during grain adaptation increased ADG and may be used as an alternative to conventional adaptation programs.

Key Words: beet pulp, feedlot, grain adaptation

201 Occurrence of hormonal residues in feedlot cattle waste. T. L. Mader[1], L. J. Johnson*[1], S. L. Bartelt-Hunt[1], D. D. Snow[1], W. L. Kranz[1], C. A. Shapiro[1], S. J. Van Donk[1], D. P. Shelton[1], D. D. Tarkalson[2], T. C. Zhang[1], and S. M. Ensley[3], *[1]University of Nebraska, Lincoln, [2]USDA-ARS, Kimberly, ID, [3]Iowa State University, Ames.*

Two identically designed studies were conducted in separate years at the UNL Haskell Agricultural Laboratory using 192 crossbred heifers (96/study). Within a study heifers (initial weight = 386kg) were randomly assigned to 2 groups (3 42.4 m × 14.6 m pens/group/year): 1) treatment (TRT) animals were administered synthetic hormones via subcutaneous implants [d 1, 36 mg zearalonal; d 35, 140 mg trenbolone acetate (TBA) and 14 mg of 17β-estradiol benzoate (Revalor-H)] and fed Melengesterol Acetate (MGA), and 2) control (CON) animals with no synthetic hormone provided. Throughout each study, feedlot pen surface samples were obtained from 4 equally-sized zones (5 surface sub-samples obtained/zone) within each pen. Runoff to waste water collection basins was also sampled. Run-off water and pen surface samples, including fresh manure, were analyzed for 16 natural and synthetic steroid hormones and their metabolites. Statistical model included year, treatment, replicate and year x treatment interaction. In pen surface samples, obtained at trial termination (d 109 for study 1 and d 138 for study 2), 4-androstenedione, andosterone, 17β-estradiol, estrone, α-zearalanol, and MGA were greater ($P < 0.05$) for TRT while progesterone and 17α-hydroxyprogesterone were greater for CON. With the exception of androsterone, average hormonal concentrations in pen surface samples were less than 11 ng/g. In runoff samples, 4-androstenedione was greater for TRT and progesterone was greater for CON. Low (55 ng/g) concentrations of 17α-trenbolone, a metabolite of TBA, was detected in fresh manure from TRT group samples collected shortly after implanting, however no TBA metabolites were detected in pen surface samples. Gains and feed conversions were 18.6 ($P < 0.05$) and 7.2% better, respectively, for TRT, while CON had 16.7% greater choice and prime carcasses. Results indicate that low levels of both natural and synthetic hormones are found in cattle waste, although TBA metabolites were not found in run-off or pen surface samples.

Key Words: animal waste, hormone levels, environment, beef cattle

202 Anaerobic digestion of finishing cattle manure with and without distillers grains in the diet. A. K. Watson*, T. J. Klopfenstein, G. E. Erickson, S. C. Fernando, J. L. Harding, and A. L. Shreck, *University of Nebraska, Lincoln.*

Two treatments (cattle diet) were used in anaerobic digestion of finishing cattle manure. Diet 1 contained 82.5% dry rolled corn (DRC) (CONT) and diet 2 contained 40% wet distillers grains plus solubles (DM basis) replacing DRC (WDGS). Cattle were housed in stanchions for 3 d with complete manure collection in a cement pit. Manure (feces and urine) was sampled and analyzed for minerals, DM and OM. Manure collected was weighed into individual allotments based on DM and frozen. Continuously stirred anaerobic digesters (n = 7, 1 L capacity) were inoculated and maintained for 5 mo before the trial to ensure steady-state. Temperature was maintained at 37°C and pH was maintained between 7.0 and 8.0 via addition of sodium hydroxide. Manure samples collected were thawed and hot water was added to bring total slurry volume to 50 mL. Each day, 50 mL of effluent was removed from each digester and replaced with 50 mL of fresh manure/water slurry (9% DM). Two collection periods were used with 35 d adaptation and 5 d collection, as a switchback. The DM and OM of effluent was measured and DMD and OMD were calculated. Concentration of methane was measured under constant flow of N_2 gas. Organic matter in manure averaged 88.3% for CONT and 88.7% for WDGS. Manure DM was 18.3% for CONT and 17.8% for WDGS. CONT and WDGS manure did not differ in total N concentration, 3.95 and 3.79% of DM, respectively ($P = 0.54$). Sulfur, P_2O_5, Mg, Zn and Fe were greater in WDGS manure compared with CONT ($P < 0.01$). Minerals were concentrated approximately 2-fold in effluent compared with manure in both WDGS and CONT. Dry matter degradation was 42.7% for CONT and 44.9% for WDGS ($P = 0.05$). Organic matter degradation was 51.0% for CONT and 52.9% for WDGS ($P = 0.10$). Methane production was 0.551 L/d for CONT and 0.634 L/d for WDGS ($P = 0.10$), equal to 0.116 and 0.137 L/g VS fed ($P = 0.05$). Feeding distillers grains to cattle does not have large impacts on methane production or degradation of manure in anaerobic digesters compared with a corn based diet.

Key Words: anaerobic digester, manure, methane

203 Effect of dietary crude protein on nitrogen emissions from beef cattle. N. Palumbo*, M. Barbosa-Chiavegato, and W. Powers, *Michigan State University, East Lansing.*

Nitrous oxide (N_2O) and ammonia (NH_3) emissions are directly affected by available nitrogen (N). The objective of the study was to determine if reducing diet CP would reduce N_2O and NH_3 emissions from steer housing or following manure application to soil. Over 2 21 d periods, 12 Holstein-cross steers were fed diets containing 10.5% (Lo) or 14% (Hi) CP (6 steers per diet in a Latin Square design). The steers were housed in rooms with NH_3 and N_2O emissions measured

continuously. Manure from d 21 of period 2 was surface applied to soil (40.6 cm deep) in 208 L tubs to determine treatment effect on emissions from soil. Experiment 1 measured emissions when similar manure mass was applied across treatments. Treatments were Hi (496 g of wet manure (4.71 g N) from steers fed Hi) and Lo (496 g of wet manure (4.12 g N) from steers fed Lo). Experiment 2 measured emissions when manure was applied using similar N application rates (targeted at 150 kg N/ha). Treatments were Hi-N (496 g of wet manure (4.71 g N) from steers fed Hi) and Lo-N (570 g of wet manure (4.73 g N) from steers fed Lo). Continuous NH_3 and N_2O emissions were collected from the headspace of the tubs for 7 d (3 replicates per treatment). All data were analyzed using mixed model procedures with date as a random effect. Diet had no effect on average daily gain or feed intake ($P > 0.05$). Steers fed Lo diets emitted less NH_3 (14.9 vs. 33.9 g/d; $P < 0.01$ and 139.0 vs. 221.1 mg/g of daily N intake; $P < 0.01$). However, there was no difference in N_2O emissions ($P > 0.05$). Applying manure based on equal manure mass (Hi vs. Lo) resulted in no differences in average daily emission of NH_3 (36.6 mg/d; $P = 0.44$) or N_2O (0.34 mg/d; $P = 0.23$) nor cumulative mass of NH_3 (292.8 mg; $P = 0.65$) or N_2O (2.71 mg; $P = 0.22$) emitted over the 7 d. Applying manure based on similar N application (Hi-N vs. Lo-N) resulted in no differences in average daily emission of NH_3 (40.6 mg/d; $P = 0.08$) or N_2O (0.46 mg/d; $P = 0.14$) nor cumulative mass of NH_3 (324.8 mg; $P = 0.08$) or N_2O (3.7 mg; $P = 0.14$) emitted over the 7 d. Reducing diet CP reduced NH_3 housing emissions. Emissions following land application of manure were not changed.

Key Words: air emissions, crude protein, manure, steers

204 Impact of Component TE-S and Component TE-S with Tylan on implant defects and performance in steers implanted under clean and dirty conditions. K. M. Retallick*[1], D. B. Faulkner[1], T. G. Nash[1], R. L. Botts[2], N. A. Pyatt[2], J. L. Bargen[2], and R. Frederickson[1], *[1]University of Illinois, Urbana, [2]Elanco, Greenfield, IN.*

The objective of this study was to determine the impact of a Tylan pellet on implant defects and resulting performance in finishing steers. British × Continental steers (n = 316; BW 314 ± 18 kg) were utilized in a 2 × 2 factorial plus negative control. Clean implant procedure (CI) was the manufacturer's recommendation; dirty implant procedure (DI) exposed the implant needle to a manure slurry. Treatments were: Control non-implanted (C), Component TE-S implanted with clean procedure (NTC), Component TE-S with Tylan implanted with clean procedure (TC), Component TE-S implanted with dirty procedure (NTD), and Component TE-S with Tylan with dirty procedure (TD). Steers were weighed and implants evaluated on d 0, 14, 28, 56, and 122. TC, NTC, and TD had 0.38 kg/d improved ADG compared with control ($P < 0.05$). There was an implant procedure x Tylan use interaction ($P < 0.05$) for final BW and DMI since TD performed similar to CI. Steers receiving the Tylan containing implant (T) had a 0.07 kg/d improvement ($P < 0.05$; carcass-adjusted basis) in ADG compared with implants without Tylan (NT). Feed efficiency (FE) tended to improve by 3.20% (carcass-adjusted basis; $P = 0.06$) compared with NT. This gave T steers a $19.49 advantage in carcass value ($P < 0.05$). Histology analysis was performed on ears collected at harvest showing an increase in capsule thickness for NT cattle and DI cattle ($P < 0.05$). On d 14, T compared with NT steers had increased ($P < 0.05$) proper (83.3 vs. 54.2%, respectively) and decreased ruptured implants (5.3 vs. 24.8%, respectively). Day 122 results were similar. On d 14 and 122, CI had increased proper and decreased ruptured implants ($P < 0.05$) compared with DI. Tylan steers with d 14 abscesses tended ($P = 0.09$) to have improved FE and increased ($P < 0.05$) carcass-adjusted ADG and HCW compared with NT cattle. In conclusion, Tylan containing implants and clean implanting procedures reduced implant defects and improved performance.

Key Words: beef, implants, defects, performance

205 Research results are dependent on accurate cattle weights. A. K. Watson*[1], T. K. Klopfenstein[1], L. W. Lomas[2], G. E. Erickson[1], and B. L. Nuttelman[1], *[1]University of Nebraska, Lincoln, [2]Kansas State University, Manhattan.*

All research trials at UNL's ARDC Research Feedlot follow a standard protocol to obtain beginning and ending BW on all animals. Cattle are penned for at least 3 d while being limit fed (LF) at an estimated 2% of BW with a 50% hay, 50% wet corn gluten feed diet (DM basis) before being weighed on 2 consecutive d to obtain an average beginning BW. For growing studies, cattle are again LF at 2% of BW for at least 3 d and then weighed on 2 consecutive d to obtain an average ending BW. The goal of limit feeding is to reduce variability in rumen fill at weighing which varies by diet. Cattle included in this study were grazing cornstalks, smooth bromegrass pasture, bermudagrass pasture, fescue pasture, range or in a dry lot on a 70% forage diet. For steers grazing cornstalks (n = 258, 325 kg), full BW off cornstalks averaged 12.5 kg less than LF BW. Full BW was −39 kg to +8 kg compared with the average of 2 d LF BW. Differences between 2 d LF BW were −23 to +15 kg. Full BW resulted in 0.14 kg/d less ADG than LF BW. Full BW averaged 10 kg greater than 2 d LF BW for steers coming off pasture (n = 644, 410 kg). Differences between full and LF BW were −49 to +45 kg. Differences between 2 d LF BW were −18 to +23 kg. Gain was 0.06 kg/d less for LF BW compared with full BW. Full BW of heifers coming off pasture (n = 231, 328 kg) averaged 5 kg greater than LF BW. Differences between full and 2 d LF BW were −32 to +26 kg. Differences between 2 d LF BW were −15 to +24 kg. Gain was 0.23 kg/d less for LF BW compared with full BW. Full BW for steers after a dry lot growing study (n = 509, 337 kg) averaged 15 kg greater than LF BW. Differences between full and 2 d LF BW were −38 to +44 kg. Differences between 2 d LF BW were −22 to +15 kg. Full BW ADG was 0.30 kg/d greater than LF ADG. Limit feeding decreases variability in BW measurements and allows forage treatments to be compared on an equal fill basis. In systems research, obtaining accurate cattle BW between components of the system (e.g., cornstalks to pasture to feedlot) becomes especially crucial.

Key Words: cattle, gut fill, weighing variation

Teaching/Animal Welfare Symposium: Teaching the Teachers–Responding to Animal Welfare Concerns

206 Multiple models for teaching animal welfare to college students. J. M. Siegford*, *Michigan State University, East Lansing.*

Animal welfare is a rapidly growing scientific field that is increasingly important to consumers, retailers, producers, and professionals and researchers in the animal sciences. College students, particularly those in animal-related fields need to understand animal welfare science as well as to navigate the complex social issues associated with the subject. At Michigan State University, animal welfare courses are offered to undergraduate, graduate and veterinary students. Each course takes a different approach but all use methods that require students to think critically, problem solve, and communicate about a complex and often controversial topic. At the undergraduate level, students can take 2 elective courses that use a traditional livestock judging approach as a format for teaching students to assess animal welfare as well as how to orally present the reasons behind their assessments in a logical way to expert judges. In the first course, students learn to evaluate the welfare of various species, considering the biological responses of the animals, their physical and social environment, and management practices. The second course culminates in the collegiate Animal Welfare Judging and Assessment Competition. A third undergraduate course is required for students majoring in animal science that covers ethical issues in animal agriculture, including those pertaining to animal welfare. The course provides students with a framework for thinking about and responding to ethical issues in a balanced way then requires them to use that framework to work through case studies. Animal welfare assessment is taught at the graduate level as a multidisciplinary online course. Lectures from prominent animal welfare experts provide an overview of the current science and related social issues. Students participate in discussions, do online surveys, complete group work, assess welfare in virtual comparative scenarios, and create a welfare scenario of their own. Veterinary students at MSU take a required course on ethical and animal welfare issues in the veterinary profession. Background lectures are followed by small group case studies and then large group discussions. In conclusion, a variety of strategies can be used to expose college students to animal welfare to teach them the science while stimulating thought and honing communication skills.

207 Teaching animal welfare in the veterinary curriculum. S. T. Millman*, *Iowa State University, Ames.*

In 2011, animal welfare was specifically included in the veterinary oath. Traditional veterinary education has not included animal welfare as a discipline in its own right, focusing on particular aspects such as animal health and pain management. Due to their visibility and trusted role as service providers for animals in society, veterinarians are sought for information on animal welfare issues. To maintain credibility and professional responsibilities, veterinary practitioners must understand basic animal welfare issues in food, companion and sporting animals and measures of animal welfare on farm and in the laboratory that are necessary for evidence-based approaches to address these issues. Furthermore, veterinarians play a unique legal role in animal cruelty response in many States, providing professional opinion regarding whether animal abuse or neglect has occurred and recommendations for rehabilitation of affected animals. Hence, recognition of animal cruelty and understanding causal factors is important in veterinary education for fulfilling this role in public health and safety. At ISU, animal welfare is included as a required core course during first year and there are additional elective courses in animal welfare judging and animal behavior. A 2-week senior clinical rotation in animal welfare targets animal welfare assessment and auditing programs, veterinary careers in animal welfare and the veterinarian's role in animal cruelty response. Students explore animal, resource and stockperson parameters used in assessing animal welfare for food animal production (i.e., PQA Plus for swine, National FARM Program for dairy, BQA for beef), entertainment (i.e., racing, AZA accreditation for zoos) and licensing of commercial animal facilities (i.e., dog breeding, animal shelters).

208 Animal welfare: Book smarts are good but practice is essential. A. K. Johnson*, *Iowa State University, Ames.*

Experiential learning is the process of making sense from direct experience. Simply put, experiential learning is learning from experience. This core value is intrinsic to all aspects of animal science, but has become exceptionally important in the area of animal welfare. The demographics of our students have changed, with fewer students coming from an agricultural background. Assuming that students can now handle and move livestock correctly, care for and identify animals in need should be taken very cautiously. In addition, students are verbalizing to their advisors that they feel inadequately prepared for animal science and feel behind their peers because of their lack of farm animal exposure before beginning their academic pursuits. At ISU we have several avenues for students to experience experiential learning. Undergraduate honors projects, Science with Practice, working in research laboratories and farms as well as through classes. Domestic animal behavior and welfare is an undergraduate elective course. Over time, the course has evolved from book smarts, to book smarts and practical application. For example, one week is dedicated to a farm species; on Tuesdays we address behavior, Wednesday is a practical laboratory and Thursday addresses welfare. For every laboratory, clear learning objectives are provided, and points garnered throughout the laboratory make sure that the learning objectives are enforced through practical application and the written word. Laboratories include, but are not limited to, welfare assessments, handling and moving livestock, identifying sick animals and designing an optimal environment for farm animals. In one laboratory, students become "cattle" and need to identify potential issues within the handling environment that may cause cattle to balk. For students to graduate with an animal science degree that is book smarts but has limited to no practical exposure to farm animals will do an ultimate disservice to our agricultural stakeholders and the animals we strive to care for and protect.

Key Words: classroom, education, practical, welfare

POSTER PRESENTATIONS

Breeding and Genetics

209P Relationship between feed efficiency measures taken during heifer development and those taken during first lactation in purebred Angus cattle. G. Dahlke* and D. Strohbehn, *Iowa State University, Ames.*

Evaluation of feed efficiency in developing heifer calves with the intention of retaining well performing individuals for a feed efficient breeding herd is a concept worthy of consideration. The objective this study was to determine if these efficient heifers still maintain this efficiency as cows. Over a 3-year period, 15 heifers per year were tested for individual feed intake. These heifers were then monitored as cows in the next year. This study defined feed efficiency as residual feed intake (RFI) and measured this trait in yearling Angus heifers and then again when these heifers became cows supporting their first calf. As heifers, RFI was calculated by regressing initial metabolic body weight and daily weight gain over feed dry matter intake. Feed intake data on the heifer was collected over a period of approximately 90 d using a pelleted ration in a Pin Pointer 4000 system. When these individuals became cows, cow intake data on a silage-hay based ration was collected over 140 d using the Iowa State Feed Intake Monitoring system. Based on the measured fixed effects the RFI calculation needed to now include initial metabolic body weight, daily weight change, daily milk production, days since lactation initiation, and the interaction between milk production and lactation initiation. This infers unique efficiencies for maintenance, weight gain and milk output and is probably the issue we should focus on in future research. The correlation between yearling and first-lactation RFI was always positive ranging from 0.44 to 0.77 over the 3 years or contemporary groups this trial was conducted with only one year providing a strong correlation with significance at less than the 0.05 level. A Student *t*-test confirmed a positive correlation between development RFI and first-lactation RFI.

Key Words: residual feed intake, heifer, cow, feed efficiency

210P Genome-wide association study for age at puberty in maternal line gilts. J. K. Tart*[1], J. W. Bundy[1], N. N. Ferdinand[1], A. M. McKnite[1], M. F. Rothschild[2], D. J. Garrick[2], P. S. Miller[1], S. D. Kachman[1], R. K. Johnson[1], and D. C. Ciobanu[1], *[1]University of Nebraska, Lincoln, [2]Iowa State University, Ames.*

Through selection and improved management, sow litter size has been substantially increased. Unfortunately, this enhancement in productivity has been associated with increased culling due to reproductive failure and ultimately decreased sow longevity. Our previous research identified age at puberty (AP) as the best pre-breeding predictor of reproductive longevity. AP has a moderate heritability and can be detected early in life, but is labor intensive to measure. A panel of DNA markers predicting AP would be more economically viable and its use could improve lifetime reproductive performance. Markers predicting AP were identified in a population of gilts from 2 maternal crossbred lines developed with either ad libitum or energy-restricted diets. AP was determined by daily heat checking from 140d to 240d of age. DNA was isolated from tail tissue of 852 gilts and genotyped using the Porcine 60K SNP BeadArray (Illumina). The GWAS employed Bayes B and Bayes C approaches with crossbred line, diet and replicate set as fixed effects, assuming 99.5% of SNPs were not associated with AP. Windows of 5 adjacent SNPs were ranked by the amount of variance they explained. Eleven regions that contained rich clusters of SNPs within 1 Mb that explain the largest variation for AP were further characterized to identify molecular sources of the phenotypic differences. Represented regions included SSC1 (88 and 269 Mb), 2 (64 Mb), 3 (14 Mb), 5 (27 Mb), 6 (85, 111 Mb), 8 (30 Mb), 9 (119 Mb), 11 (45 Mb) and 12 (1 Mb). Two regions (SSC1 at 269 Mb and SSC12 at 1 Mb) had previously been found to harbor QTL associated with AP. Potential candidate genes included CRTC1 (SSC2), found to be associated with AP in humans, and PRKAA2 (SSC6), a catalytic subunit of AMPK, an important sensor of energy metabolism. The incorporation of identified markers can aid in prediction of AP and may be used to select animals with early puberty onset and superior lifetime reproductive performance.

Key Words: GWAS, pig, puberty, sow longevity

211P Effects of sow, boar, and semen traits on sow reproduction. S. Park*[1], T. A. Rathje[2], and R. K. Johnson[1], *[1]University of Nebraska, Lincoln, [2]Danbred North America, Columbus, NE.*

The objective was to estimate the effect of traits recorded in females and in boars and their semen on farrowing rate (FR), total number (TB) and number of stillborn pigs (SB) at birth, and number of live pigs at day-5 of lactation (LP5). Results of 20,569 inseminations in 4,468 sows on 4 farms with semen from 856 boars in 2 AI centers were analyzed. Records on sows included parity, age at insemination, number of inseminations per estrous period, and return to estrous data. Records on boars included age of boar and time of day when semen was collected, number of days rest between collections, and 27 characteristics (e.g., volume, sperm concentration, motility, abnormal heads and tails plus 16 traits that described velocity and path of sperm cell movement). Data were analyzed with SAS PROC MIXED in models accounting for fixed effects of breed and parity of sow, random effects of sow and boar, and regressions of sow reproductive traits on sow, boar, and semen traits. Models were first fitted with only linear regressions; if important ($P < 0.10$), 2nd models including quadratic effects were fitted. Parity and the interval from 1st insemination (1st estrous during breeding period in gilts, and 1st post-weaning estrus in sows) to the insemination that resulted in a litter affected ($P < 0.01$) FR, TB, and LP5; parity also affected SB ($P < 0.01$). Average FR declined in a quadratic manner by 0.14 as the interval from 1st insemination to insemination of conception increased from 0 to 75 d. Sow reproductive traits were not affected ($P > 0.10$) by age of boar or time of day when semen was collected, number of days between collections (all boars had at least 3 d rest) or semen volume, sperm concentration, sperm motility, or percentage of abnormal heads and tails (minimum standards for these traits were used to screen semen). Nine traits describing semen travel affected sow reproduction ($P < 0.10$), but differences across the range of variation were relatively small.

Key Words: boar, semen, sow reproduction

Extension: Beef/Small Ruminant

212P Effects of pasture size on the efficacy of off-stream water or restricted stream access to alter the spatial/temporal distribution of grazing cows. J. Bisinger* and J. Russell, *Iowa State University, Ames.*

For 2 yr, 6 12.1-ha cool-season grass pastures were used to determine the effects of grazing management and pasture size on cow distribution. The experimental design was a 3 × 2 switchback with 3 grazing management treatments: unrestricted stream access without off-stream water (U), unrestricted stream access with off-stream water (UW), and restricted stream access to 4.9-m wide stabilized crossings (R); and 2 pasture sizes (small (4.0 ha) and large (12.1 ha)) alternated at 2-wk intervals for 5 4-wk periods of each grazing season. In each year, small and large pastures were continuously stocked for each 2-wk interval from mid-May through mid-October with 5 and 15 fall-calving cows, respectively. During each interval, 2 or 3 cows in each pasture were fitted with GPS collars that recorded cow position at 10-min intervals. After each interval, cow location was classified as being in the stream (0 to 4.6 m from the stream), streamside (4.6 to 33.5 m from the stream), or upland (greater than 33.5 m from the stream) zone on aerial maps with ArcGIS 10. In yr 1, the proportion of time cows spent in the stream zone was lower ($P < 0.05$) in large than small pastures with the U treatments in periods 4 and 5 and with the UW treatment in periods 2, 3, 4, and 5. Cows in small R pastures spent less ($P < 0.05$) time in the stream zone than cows in small U or UW pastures in each period. Cows in the U and UW pastures spent less ($P < 0.05$) time in the streamside zone of large than small pastures in every period. The proportion of time cows in R treatment spent in the streamside zone was lower ($P < 0.05$) in small pastures and tended to be lower in large pastures than cows in the U or UW treatments in every period. Regardless of pasture size, the proportion of time cows were in the stream or streamside zone was not reduced by the UW treatment. Pasture size was a major factor affecting congregation of cows in or near pasture streams with unrestricted access.

Key Words: beef cattle, distribution, grazing

213P Low stress cattle working facility. V. L. Anderson* and B. R. Ilse, *North Dakota State University, Carrington.*

Cattle working facilities at the Carrington Research Extension Center (CREC) Livestock Unit were renovated to reduce labor requirements, increase rate of processing, and minimize stress on the animals and herdsmen. Little public sector information has been published that provides guidance on the principles of designing low stress facilities. To accomplish this, individuals with extensive experience working cattle at producer and university facilities participated in a round table conference and developed a simple, logical and agreeable plan. The plan considered the size of the existing building, and cattle inflow and exit sites. While the plan was adapted to the available area for the research mission at CREC, the principles of the working facility may be scaled up for commercial operations. The renovation included all-weather ceiling lights to eliminate dark areas and shadows. The previous working facility was a single animal entry door 0.85 m wide leading to straight line single animal alley that included one animal space before a scale followed by a squeeze chute and exit. The new design increased the barn entry to 2.2m with a 3.7m wide lane segmented by gates along the 22.7m length of the barn, at the end of which animals make a right angle entry into a staging area or "Bud" box. A blocking gate is then closed so animals turn around, and readily enter the double ally next to the blocking gate hinge. A single animal scale, and a Silencer® squeeze chute are fed by the double alley. This facility requires 2 fewer people to process cattle and cattle are handled at nearly twice the previous rate based on timed processing events. Numerous producers have inquired and adapted the concept in their own facilities with highly positive responses, including an auction barn that uses this concept for ring entry and loading cattle.

Key Words: cattle, low-stress, working facility

214P Modeling the dynamics of Johne's disease in dairy herd populations. B. Olthoff*, Y. Kigeneh, G. De Young, and J. Olthoff, *Dordt College, Sioux Center, IA*.

Johne's disease, *Mycobacterium avium* ssp. *paratuberculosis* (MAP), affects an estimated 68% of US dairy herds with costs up to $800 per infected animal. The disease has a long incubation, periods of shedding latency, unreliable test methods, and multiple transmission routes. This makes it difficult to assess long-term effects of MAP on a herd, or responses to control methods. A dynamic model based on differential equations was developed with the Vensim simulation program. The model simulated qualitative changes in dairy herd population dynamics in response to MAP. Equations were derived using Sage mathematics software. Cattle were grouped by susceptibility and disease status. Susceptibility decreased as the cattle moved through age groups. Infected animals moved through 4 disease stages with different shedding rates: transient (TR), latent (L), low shedders (SL), and clinical high shedders (SH). Cows in the SH stage were culled. Transmission routes included fecal contamination, placental transfer and infected colostrum. Calving area and calf housing were high risk environments. Cleaning rate quantified the proportions of MAP removed from the environments by management. This variable characterized management. Cull rates were the proportion of animals removed from each age group. Initial parameter values were set to maintain a stable herd size. Changes over a 40 year period were simulated. Culling rate and reproductive rate variables had the greatest influence on herd steady state. The transition rate between the susceptible calves and TR heifers had the greatest influence on herd size stability. Calving environment cleaning rate and cull rates for SL and SH cows determined that transition. Simulating a 600 cow closed herd with a poor cleaning rate demonstrated a 66% drop in cow numbers over 40 years due to the presence of MAP relative to the same herd with high cleaning rate. Incorporating a Johnes vaccine into the simulation did not demonstrate any advantage over a high cleaning rate. A combination of culling and cleaning provided optimal MAP control.

Key Words: Johne's, dairy, simulation, modeling

215P Development of a procedure to reproduce the variance and relationships amongst carcass measurements and the weight of primal and subprimal lean cuts. M. R. Lawlor[2], B. A. Craig[2], A. P. Schinckel*[1], M. E. Einstein[1], S. Jungst[2], J. O. Matthews[2], B. Fields[2], C. Booher[2], T. Dreadin[2], C. Fralick[3], S. Tabor[4], A. Sosnicki[3], E. Wilson[3], and R. D. Boyd[4], *[1]Purdue University, West Lafayette, IN, [2]PIC North America, Hendersonville, TN, [3]Swine Tek, Convoy, OH, [4]The Hanor Company, Franklin, KY.*

The objective of this research was to evaluate and develop a method to reproduce the variation in pork primal and sub-primal cut weights. Barrows (n = 2,178) and gilts (n = 2,274) were fed either high energy (HE; 3.53 to 3.55 Mcal ME / kg) or low energy (LE; 3.27 Mcal ME / kg) diets from 27 kg BW to target BWs of 118, 127, 131.5, and 140.6 kg. The pigs from 4 sire lines were born over 10 moly replicates. Backfat depth and loin depth measurements were taken with an optical probe 7 cm off-midline between the third and fourth from the last ribs. Primal and sub-primal cut weights were collected from the left side of each carcass. The cut weights and carcass measurements for each pig (optical probe backfat and loin depths) were fitted to allometric functions ($Y = A\ CW^{B}$) of carcass weight (CW). The final model was cut weight = random effect of replicate + $[1 + b_D\ (Diet)]\ [A\ (CW^B)]$ where Diet = −0.5 for the LE and 0.5 for HE diets, and A and B are sire line–sex specific parameters. Linear regressions of backfat and loin depth residuals from the same model were included at $P < 0.05$ to some of the equations but had little impact to reduce the residual variance. The R^2 of these functions ranged from 0.305 to 0.727 indicating that primal and sub-primal cut weights have substantial variation even within pigs of the same sire line, sex, and CW. The residuals among the primal and sub-primal cuts were correlated ($P < 0.01$) and a Cholesky decomposition procedure was used on the variance–covariance matrix of the residuals. By using these procedures, a stochastic model can be used to evaluate the impact of alternative management and marketing strategies on the mean and distribution of pork primal and sub-primal cut weights.

Key Words: pork, carcass, primal cut weight, stochastic model

216P Developing a stochastic model to estimate optimum market weight for PIC pigs. S. Jungst*[1], N. Matthews[1], A. Schinckel[2], M. Einstein[2], B. Fields[1], and A. Sosnicki[1], *[1]PIC North America, Hendersonville, TN, [2]Purdue University, Department of Animal Sciences, West Lafayette, IN.*

Pork producers need a tool to evaluate alternative target market weights and barn close-out strategies under different economic conditions. A stochastic model was developed to evaluate optimum market weights and marketing strategies for PIC genetics. Data were used from a growth trial that included pig BW and carcass data and pen feed intake data. Growth curves were developed for barrows (n = 2,178) and gilts (n = 2,274) from 4 PIC sire lines fed low energy (3.14 to 3.19 Mcal ME/kg) or high energy (3.41 to 3.45 Mcal ME/kg) diets from 27 kg to 141 kg using a generalized Michaelis-Menten (GMM) function; $WT = WT_0 + \{[(WF - WT_0) \times (t/K)^C] / [1 + (t/K)^C]\}$. Feed intake was measured on 201 barrow and 196 gilt pens. A Bridge's function was fit to pen daily feed intake (DFI); $DFI = C \times \{1\text{-}exp(\text{-}(exp(M')) \times (WT^A))\}$. Random animal and pen effects were fit in the GMM and Bridge's models, respectively using the NLMIXED procedure of SAS. Carcass weight (CW) was fit to an allometric function of BW; $CW = A \times BW^B$. Backfat (BF) and loin depth (LD) measurements were fit to an allometric function of CW; BF or $LD = A \times CW^B$. The REG procedure in SAS was used to analyze the carcass traits. Estimates of the standard deviations of each trait were multiplied by 2,400 standard normal deviates to reproduce the variation for each trait measured. The stochastic model simulates the individual pig BW, DFI, CW, BF, and LD growth for a 2,400 head finisher from 70 to 230 d of age. The user of the model provides inputs for sire line, facility costs, feed cost, diet energy level, base carcass price, the option of up to 4 marketing pulls of various percentages plus a barn close out, the standard deviation in BW, transport costs from the farm to the harvesting facility and the pork processor where they market their pigs. Output from the model is the optimum market weight for each marketing pull and margins above feed, housing, and transport costs.

Key Words: pig, growth model, feed intake

217P Use of mixed model nonlinear functions to adjust pig growth and measurement data. A. P. Schinckel[1], M. E. Einstein[1], D. Marois[2], and D. N. Hamilton*[2], *[1]Purdue University, West Lafayette, IN, [2]Genetiporc Inc., St. Bernard, Beauce, Canada.*

Current methods to adjust pig performance data to a constant BW or age assume linear relationships between the growth of the trait measured and either age or BW. Serial BW and ultrasonic measurements from a set of 110 gilts were used to provide an example of the development of alternative methods to adjust pig performance data. Each pig was weighed at approximately 125, 138, 153, 167, and 174 d of age. Ultrasonic backfat depth and loin depth measurements were collected at each weigh day on approximately one-half of the gilts. The BW data were fit to a mixed model Generalized Michaelis-Menten (GMM) function with a pig specific random effect for mature BW (mean mature BW = 394 ± 36 kg with a between pig variance of 1037 ± 249 kg^2, RSD = 3.0 kg, $R^2 = 0.970$). By including each pig's random effect, the pig's predicted age to achieve target BWs were estimated. An allometric equation $Y = (1 + a_i)\ A\ BW^B$ with a pig specific random effect (a_i) provided the best fit of the ultrasonic data to BW. The variances of the a_i values were 0.0262 ± 0.0024 for backfat depth and 0.0077 ± 0.0004 for loin depth. The random effects were significant in both models ($P < 0.01$) and reduced the residual variances. An alternative approach to adjust pig growth or measurement data are to use mixed model nonlinear equations. The pig's actual data was used to solve for its specific random effect. Then, using the nonlinear equation and the pig's random effect, the pig's measurement at the target age or BW can be estimated. This alternative approach may better predict the mean and variances of each pig′s growth and better adjust pig performance data.

Key Words: pig, growth, ultrasound, adjustment

218P Use of a stochastic model to determine the complex relationships between key production inputs of economic importance and optimum market weight of market pigs. N. Matthews*[1], S. Jungst[1], A. Schinckel[2], M. Einstein[2], B. Fields[1], and A. Sosnicki[1], *[1]PIC North America, Hendersonville, TN, [2]Purdue University Department of Animal Sciences, West Lafayette, IN.*

A stochastic model was developed to evaluate optimum market weight (OMW) and marketing strategies for PIC genetics (Jungst et al., 2012). The stochastic model uses body weight (BW) growth curves, feed

intake curves, allometric functions of BW to estimate carcass weight, and allometric functions of carcass weight to estimate backfat and loin depth measurements. The model runs on a SAS-based platform and results are in a PDF report format. The model simulates the growth of 2,400 pigs from 70 to 230 d of age with biological variation included in the simulation. On each day of growth, the model estimates the cost of production, value of pigs at marketing, and margins above feed, housing, and transport costs. The OMW is the average BW on the day of growth in which margins are maximized over the 160 d range. The model includes user inputs for sire line, facility costs, feed cost, dietary energy level, base carcass price, the option of up to 4 marketing pulls of various percentages plus a barn close out, the standard deviation in BW, transport costs at marketing and the payment matrix where the pigs are marketed. The model allows simulation scenarios using any combination of the user inputs to determine OMW and maximum margins. Through simulations, a better understanding of how each factor independently or collectively affects OMW and margins above costs can be obtained. Numerous scenarios can be ran, such as feeding low vs. high energy diets to determine if the trade-off for a less expensive diet resulting in poorer feed efficiency and better leanness results in greater margins than in a more expensive high energy diet that delivers better feed efficiency and poorer carcass leanness. The ability to better understand the complexity of production inputs of economic importance and OMW enables pig producers to improve profitability.

Key Words: pigs, growth model, economics, market weight

219P Effect of birth weight and weight gain in the first 24 h on preweaning piglet survival. P. J. L. Ramaekers*[1], I. Huerta[2], and H. M. J. van Hees[1], *[1]Nutreco Swine Research Centre, Boxmeer, the Netherlands, [2]Magapor S.L. Technical Services, Zaragoza, Spain.*

In 2 experiments, 191 Hypor primi and multiparous sows were used to examine the effect of birth weight and weight gain in the first 24 h on preweaning piglet survival. In exp. 1, 67 sows received feed containing 2300 kcal NE sow and 0.68% apparent digestible lysine. Farrowing was not induced. In exp. 2, 124 sows received feed containing 2350 kcal NE sow and 0.75% apparent digestible lysine. In this experiment farrowing was induced using 2 mL Prostaglandin2α at d 113 of pregnancy and 1 mL of oxytocin after 24 h. In both experiments, litters size was standardized after 24 h on 12 and 13 piglets for primi and multiparous sows, respectively. Piglet′s individual body weights were measured at birth and about 24 h after birth and body weight gain in the first 24 h was calculated. Piglet mortality was recorded until weaning. Data of 2289 piglets was analyzed. Piglets were classified on birth weight (BiW, ≤1000 g, >1000 g) and weight gain in the first 24 h (Gain24, ≤25 g, >25 g). Survival rate was analyzed with Proc Freq of SAS. In exp 1, parity no, no born alive, BiW ≤1000 g, BiW >1000 g, Gain24 ≤25 g and Gain24 >25g were 3.0, 12.7, 851 g, 1534 g, −43 g and 138 g, respectively. In exp 2, parity no, no born alive, BiW ≤1000 g, BiW >1000 g, Gain24 ≤ 25 g and Gain24 > 25g were 2.5, 13.8, 870 g, 1424 g, −37 g and 114 g, respectively. Piglet survival rates are presented in Table 1. Our results show that Gain24 is more importance for survival of light weight piglets than for normal weight piglets. However, also for normal weight piglets Gain24 is important for survival. Colostrum intake is the main gain in the first 24 h and prevents piglets from hypothermia. It is concluded that piglet BiW and Gain24 are of vital importance for preweaning piglet survival.

Table 1. Preweaning piglets survival rates of exp. 1 and 2

Exp. 1		BiW ≤1000 g	BiW >1000 g	*P*-value
Gain24 ≤25g	Survival rate (%)	37	84	<0.01
Gain24 >25 g	Survival rate (%)	95	98	<0.01
	P-value	<0.01	<0.01	
Exp. 2		BiW ≤1000 g	BiW >1000 g	
Gain24 ≤25 g	Survival rate (%)	45	79	<0.01
Gain24 >25 g	Survival rate (%)	91	96	<0.01
	P-value	<0.01	<0.01	

Key Words: piglet survival, birth weight, weight gain

220P Apparent and standardized ileal amino acid digestibilities in black-seeded *Brassica napus* and yellow-seeded *Brassica juncea* in growing pigs. N. Sanjayan*, J. .M. Heo, and C.M. Nyachoti, *University of Manitoba, Winnipeg, MB, Canada.*

The purpose of the study was to determine the apparent (AID) and standardized ileal digestibilities (SID) of yellow seeded *Brassica juncea* (*B. juncea*) compared with conventional black seeded *Brassica napus* (*B. napus*) in growing pigs. Six barrows (initial BW, 20.7 ± 1.5 kg), each fitted with a T-cannula at the distal ileum, were used to determine AID and SID of amino acids (AA) in *B. juncea* and *B. napus*. Pigs were allotted to diets containing either *B. juncea* or *B. napus* as the sole source of protein and formulated to contain 14% crude protein (CP) in a replicated completely randomized design. The pigs were fed their respective diets in 2 equal portions at 0830 and 1630. Daily feed allowance is based on the pig BW at the beginning of the period and is calculated to supply 2.6 times the estimated maintenance requirements. The experiment lasted for 9 d. Pigs were adapted to experimental diets for 7 d followed by 12 h of continuous ileal digesta collection on d 8 and 9 to determine AID. The SID of CP and AA were determined by correcting AID values for basal endogenous AA losses using published values. Titanium dioxide (3 g/kg) was included in the diets as an indigestible maker. The AID (%) of DM (73 vs. 72), energy (77 vs. 75) and nitrogen (62 vs. 64) were not different ($P > 0.05$) between *B. juncea* and *B. napus*. The SID (%) of CP (79 vs. 80), Ile (80 vs. 80), Leu (81 vs. 80), Lys (77 vs. 79), Phe (68 vs. 71), Met (87 vs. 84), Thr (75 vs. 77) and Val (80 vs. 79) for indispensable AA and Asp (80 vs.78), Glu (89 vs. 88), Tyr (79 vs. 79), Arg (92 vs. 90), Ala (78 vs. 78), Cys (80 vs. 80) and Ser (79 vs. 81) for dispensable AA were similar ($P > 0.05$) between *B. juncea* and *B. napus*. The results indicate that *B. juncea* had similar AID and SID values of AA, DM, energy and nitrogen compared with *B. napus*.

Key Words: apparent ileal digestibility, canola meal, pigs, standardized ileal digestibility

221P Use of indirect calorimetry to determine the net energy (NE) content of canola meals in growing pigs. J. M. Heo*, D. Ayoade, and C. M. Nyachoti, *University of Manitoba, Winnipeg, MB, Canada.*

The NE is the most superior and accurate measure of available energy value of feeds compared with the measures of DE or ME contents. However, the most of values of the NE content are estimated by published prediction equations. The objective of this study was to evaluate the NE content of canola meals in growing pigs using an indirect calorimetry (Columbus Instrument, OH, USA). The study was conducted as a completely randomized design (n = 6), with factors being (1) a basal diet, (2) 2 diets containing 700 g/kg of basal diet and 300 g/kg

of 2 different types of canola meal diets (i.e., *B. napus* yellow vs. *B. juncea* yellow). A basal diet was formulated to meet all the nutritional requirements for growing pigs (NRC, 1998). Eighteen growing male pigs were used (initial BW of 14.9 ± 0.11 kg). Pigs were fed for 15 d at 550 kcal ME/kg BW0.60/d (high ME intake) for determination of DE and ME in metabolism crates. Thereafter, all pigs were individually housed in the indirect calorimetry to measure O2 consumption and CO2 production for 36 h to determine heat production (HP), including high ME intake for 24 h and fasting HP (FHP) for 12 h. Digestible energy content of *B. napus* yellow (BNY) meal diet and *B. juncea* yellow (BJY) meal diet was 3,276 and 3,470 kcal/kg DM, respectively. Metabolizable energy and retained energy contents of BYN meal diet and BYJ meal diet were 3,062 and 3,229 kcal/kg DM, and 1,310 and 1,364 kcal/kg DM, respectively. The FHP of BYN meal diet and BYJ meal diet were 1,039 and 1,069 kcal/kg DM. Thus, the net energy content was 1,921 and 2,201 kcal/kg DM for BYN and BYJ. These values of the NE content were close to the values obtained with a prediction equation (Noblet et al., 1994) based on chemical composition of feed ingredients (2,277 and 2,413 kcal/kg DM for BNY and BJY, respectively), which suggest that the values of the NE content of feed ingredients could be accepted from both use of indirect calorimetry and prediction equations.

Key Words: canola meal, indirect calorimetry, net energy

222P Wound score comparison among gestating sows housed in two different group sizes on a commercial swine farm. T. A. Guthrie*[1], R. O. Bates[1], E. Ferry[1], D. W. Rozeboom[1], G. May[1], and B. Barton[2], *[1]Michigan State University, East Lansing, [2]Barton Farm Co., Homer, MI.*

Sow gestation housing has received noteworthy attention. In Michigan, elimination of sow gestation stalls is set to become law in 2020. Fighting occurs among sows when mixed and/or reassigned in pen housing situations. The objective of this study was to compare wound scores among gestating sows housed in 2 different group sizes. Group size of 10 (small) or 20 (large) sows provided 1.41 m2of floor space at placement were compared across 3 replicates (n = 90). The small group pen dimension was 2.4 by 4.9 m while the large group pen dimension was 2.4 by 5.8 m. Gestating sows were fed 3 times per day utilizing automatic feed drops spaced 0.6 m across each respective pen with a targeted amount of 1.8 kg of feed per sow delivered daily. Feed was dropped onto a 2.43 m wide concrete pad located in the center of the pen spanning the length of the pen. Sows were evaluated for BCS and those with similar BCS were placed in to pens at 6 d of gestation and evaluated for BCS and wound scores on d 0, 7, 30, 60 and 90 after placement, respectively. Wound scores of the neck, shoulder, side, rump were recorded on a scale from 0 to 5, with 0 representing no wounds, 1) 1 to 20% of body area in wounds, 2) 21 to 40%, 3) 41 to 60%, 4) 61 to 80% and 5 representing more than 80% or the area covered in wounds, respectively. Vulva scores were recorded on a 0 to 3 scale with 0 indicating no wounds, 1 minor wounds, 2 moderate and 3 extensive wounds. There were significant differences in shoulder wounds ($P < 0.01$), side wounds ($P < 0.001$) and rump wounds ($P < 0.05$) with gestating sows housed in the larger groups having increased odds of wound occurrence. It is apparent that gestating sows housed in larger groups in this study were more susceptible to greater occurrences of wounds.

Key Words: gestating sows, housing, wound scores

223P Assessment of pork producer educational needs for adoption of group sow housing. E. A. Ferry*, R. O. Bates, T. A. Guthrie, D. W. Rozeboom, and G. A. May, *Michigan State University, East Lansing.*

Sow gestation housing has become a primary concern for many pork producers across the United States. In Michigan this area of animal well-being has increasing importance due to a 2009 law which requires elimination of stall housing for sows once confirmed pregnant by 2020. Pork producers in Michigan ranked this as an area of future concern. Michigan State University Extension (MSUE) completed focus groups that allowed producers and key employees to vocalize and identify issues they see surrounding group housing and asked them to rank them in order of importance. Pork producers and employees were also asked to indicate their preferred method of educational program delivery regarding group housing. Three focus groups of producers and employees from farms of various size and structure were conducted. Educators and specialists from MSUE facilitated the sessions. Topics were identified and ranked in order of importance and aggregated across focus groups. Regarding strategic planning, participants indicated their top 3 educational needs were 1) remodel options, 2) feeding systems and 3) employee training. For tactical and implementation planning, participants indicated their highest 3 priorities were 1) defining sow groups, 2) stockperson training and 3) medical care. Notably for both strategic and tactical planning, employee training and education were areas of concern. Participants also indicated their preferred educational delivery methods for each topic. Overall producers showed preference for internet based methods and consistently wanted on-demand access to information that could be accessed from an internet bulletin board containing information and tools. However it was also evident that producers wanted some educational offerings through more traditional methods (face-to-face common location, face-to-face on-farm, one-on-one on-farm). This was particularly true for employee training with 37% indicating a preference for these traditional methods of educational program delivery.

Key Words: sow housing, gestation, focus groups, group housing issues

224P Effects of pelleting sodium metabisulfite ($Na_2S_2O_5$) or pelleting diets or dried distillers grains with solubles (DDGS) contaminated with deoxynivalenol, on nursery pig performance. H. L. Frobose*[1], E. D. Fruge[2], M. D. Tokach[1], E. L. Hansen[2], J. M. DeRouchey[1], S. S. Dritz[1], R. D. Goodband[1], and J. L. Nelssen[1], *[1]Kansas State University, Manhattan, [2]Hubbard Feeds, Mankato, MN.*

A total of 1,180 mixed sex pigs (initial BW 11.1 kg and 35 d of age) were used in a 21–d growth trial evaluating the effects of pelleting, pelleting DDGS, and the influence of sodium metabisulfite (SMB) in naturally deoxynivalenol (DON)–contaminated diets on nursery pig performance. The study was conducted concurrently under university (7 pigs/pen) and commercial (28 pigs/pen) conditions. At weaning, pigs were weighed and allotted to one of 7 treatments (5 replicate pens at each location) in a 2 × 3+1 factorial with factors being 1) Diet form: meal or pellet, 2) DDGS source: positive control (PC; < 0.5 ppm DON), negative control (NC; 5.5 ppm DON), or NC DDGS pelleted and crumbled before mixing into the final diet. A seventh treatment (5.5 ppm DON), in meal form, included 2.5% SMB before pelleting DDGS (0.77% SMB in final diet). All diets contained 30% DDGS. Pelleting the final diet improved ($P \leq 0.001$) ADG and G:F, but did not alter ADFI. Feeding high DON reduced ($P \leq 0.001$) ADG and ADFI, but did not influence G:F. Pelleting the high DON DDGS alone had no effect on ADG or ADFI; however, there was an interaction ($P \leq 0.04$) for G:F where G:F was improved when high–DON DDGS were pelleted before adding to a meal diet, but not when added to a pelleted diet. Adding SMB to DDGS before pelleting and crumbling into a meal diet improved ($P \leq 0.01$) ADG and ADFI, however, G:F was not affected. These results suggest that when feeding diets containing DON, pelleting diets may be able to help mitigate DON–associated reductions in performance. Although pelleting the DDGS before presenting in the final diet had minimal effect, adding SMB before pelleting appears to impact DON concentrations in the final diet and may offset performance losses associated with DON diets.

Table 1. Effects of pelleting DDGS (PDDGS), pelleting and SMB on performance of pigs fed high-DON diets

		Treatment				P <			
Item	Form[1]	PC	NC[2]	NC + PDDGS[2]	NC + PDDGS/ SMB[2]	DON	Pellet vs Meal	Pellet × DDGS	SMB
ADG, g	M	584	520	543	577	0.001	0.001	0.001	0.005
	P	628	582	581					
ADFI, g	M	881	791	799	848	0.001	0.68	0.94	0.01
	P	875	801	807					
G:F	M	0.66	0.66	0.68	0.68	0.45	0.001	0.04	0.95
	P	0.72	0.73	0.72					
Analyzed DON, ppm[3]	M	<0.5	4.1	4.0	2.2				
	P	<0.5	3.9	4.1					

[1]Diet form: meal (M) or pellet (P).
[2]Formulated to 5.5ppm DON.
[3]Combination of DON and Acetyl-DON.
SEM was 10.5, 18.0 and 0.68 for ADG, ADFI, and G:F.

Key Words: deoxynivalenol, nursery pig, pelleting, sodium metabisulfite

225P Feedlot performance of steers fed distillers grains containing 10 to 12% fat. J. L. Veracini*[1], P. M. Walker[1], R. E. Hall[2], M. J. Faulkner[1], R. L. Atkinson[3], and B. R. Wiegand[4], *[1]Illinois State University, Normal, [2]Cooperative Research Farms, Richmond, VA, [3]Southern Illinois University, Carbondale, [4]University of Missouri, Columbia.*

Modified wet distillers grains (DGS) have become a common replacement for shelled corn. Previous studies have evaluated DGS inclusion into feedlot diets but little information exists regarding the effect of DGS crude fat concentration on performance and carcass characteristics. The objective of this study was to evaluate performance of steers fed DGS containing 10–12% fat at 0, 25, 40, and 70% of the diet DM. Two hundred 40 Angus cross steers (335 ± 55 kg) were blocked by source and stratified within block (3 blocks) by BW to 32 treatment pens containing either 6 or 10 steers/pen. Pens were randomly assigned to one of 4 diets containing 15% corn silage: 1) 80% shelled corn/ 5% soybean meal (CON); 2) 25% DGS/ 60% shelled corn (25 DGS); 3) 40% DGS/ 45% shelled corn (40 DGS); 4) 70% DGS/ 15% shelled corn (70 DGS). Target BW at harvest was 641 kg, with 121 steers harvested on d 161 and 117 steers on d 224. Hot carcass weight and liver abscess scores were recorded on d of harvest. Longissimus muscle area, rib fat thickness, marbling score, and KPH fat were measured after a 20 4 h chill. Marbling score was estimated by a trained USDA grader. Yield grade was determined by formula calculation. No significant differences were observed between treatments regarding ADG or G:F. Steers fed CON had significantly lower ADFI than steers fed DGS. Steers fed 70 DGS had lower ($P \leq 0.05$) DMI compared with steers fed lower DGS concentrations. No significant differences in any of the carcass parameters evaluated were observed. Mean quality grade was average choice. Mean yield grade was 3.0. There was a non-significant ($P = 0.10$) trend for steers fed 70 DGS to have smaller rib eye areas and lower quality grades than steers fed lower DGS inclusion rates. Overall DGS with higher fat concentration (10.4%) can be fed up to 70% of diet DM without compromising feedlot performance or carcass characteristics.

Key Words: distillers grains, steer, performance, carcass

226P Evaluation of replacing corn and soybean meal in lactating dairy cow diets with field peas (*Pisum sativum*) on ruminal pH, ammonia and volatile fatty acid (VFA). J. J. Albrecht*, K. F. Kalscheur, A. R. Hippen, and D. J. Schingoethe, *South Dakota State University, Brookings.*

Four ruminally cannulated lactating Holstein cows in a 4 × 4 Latin square design were used to evaluate the effect of replacing corn and soybean meal with field peas (FP) on rumen characteristics. Cows were 170 ± 46 DIM, produced 35.1 ± 2.5 kg of milk, weighed 727 ± 54 kg at the start of the study. All 4 diets contained 37.5% corn silage and 12.5% alfalfa hay (50:50 forage to concentrate) and were formulated to replace corn and soybean meal with FP at 0 (FP0), 12 (FP12), 24 (FP24) and 36% (FP36) (DM basis) of the diet. Periods were 28 d with rumen fluid collected on d 26. Rumen fluid was sampled with a strainer and syringe from 3 locations within the rumen at 0, 2, 4, 6, 8, 12, 16, and 24 h relative to feeding. Treatment × h interactions were not observed. Ruminal pH (6.38, 6.15, 6.11, and 6.21 with SEM = 0.13 for diets FP0, FP12, FP24, and FP36, respectively) responded quadratically ($P = 0.02$). Ruminal ammonia (7.99, 8.36, 11.57, and 8.64 mg/dl with SEM = 1.43) had a cubic response ($P < 0.01$). Rumi-

nal acetate (66.3, 68.2, 65.3, and 67.1 mol/100 mol with SEM = 0.65) responded cubically ($P < 0.01$). Ruminal propionate (18.0, 17.8, 19.8, and 18.4 mol/100 mol with SEM = 0.33) had a cubic response ($P < 0.01$). Ruminal butyrate (10.8, 9.8, 10.2, and 10.1 mol/100 mol with SEM = 0.31) responded quadratically ($P < 0.01$). Ruminal iso-butyrate (1.24, 0.99, 1.06, and 1.08 mol/100 mol with SEM = 0.07) had a quadratic response ($P < 0.01$). Ruminal iso-valerate (2.01, 1.65, 1.88, and 1.74 mol/100 mol with SEM = 0.06) responded cubically ($P < 0.01$). Ruminal valerate (1.68, 1.55, 1.72, and 1.58 mol/100 mol with SEM = 0.10) had a cubic response ($P < 0.01$). Acetate to propionate ratio (3.71, 3.85, 3.33, and 3.68 with SEM = 0.10) demonstrated a cubic effect ($P < 0.01$) because FP12 had the greatest ratio while FP24 had the least. Total VFA concentration (94.8, 101.3, 103.1, and 100.1 mmol with SEM = 5.28) were quadratically different ($P = 0.02$). Replacing corn and soybean meal with FP affected total VFA concentration quadratically, showing that FP inclusion in the diet is beneficial up to 24% (DM basis) of the diet for VFA production.

Key Words: field peas, rumen fermentation

227P Effects of low fat modified wet distillers grain with solubles on beef cow performance. M. Faulkner*[1], P. Walker[1], R. Atkinson[2], L. Forster[3], J. Carmack[1], and K. Jones[2], *[1]Illinois State University, Normal, [2]Southern Illinois University, Carbondale, [3]Archer Daniels Midland Co, Decatur, IL.*

The objective of this 3-yr study was to determine the optimum inclusion rate for low fat modified wet distillers grains with solubles (DGS) in late gestation and early lactation beef cow diets and the effect of including higher dietary levels of DGS on dystocia, and postpartum conception rate. In each of the 3 years, 128 Angus-Simmental cows were blocked by parity and stratified within parity by BW subject to variation in BCS to 16 pens. Four diets were fed until completion of a timed (AI). During yr 1, control cows (T1) were fed corn silage (CS), shelled corn (SC), and soybean meal (SBM) based diets to provide 12% CP. In treatment diets, DGS replaced SC, SBM, and a portion of CS to provide 12% (T2), 16% (T3) or 20% (T4) CP. Analyzed dietary values for CP were 12.0%, 12.5%, 15.7%, and 19.0%, for T1, T2, T3, and T4, respectively. Mean DMI were 9.4 ± 1.0, 9.5 ± 1.0, 10.4 ± 1.3, 10.5 ± 1.1kg for T1, T2, T3 and T4. No differences ($P > 0.05$) between treatments were observed for calving ease score (CES), calf birth weight, calf BW at A.I., and cow BCS. Cow BW change and milk production were not significantly different but a numerical increase in cow BW was shown for T4 and in milk production for T3 compared with other treatments. During yr 2 and 3 control cows (T1) were fed the same feedstuffs as in yr 1 to provide a 10.5% CP diet. In treatments 2, 3, and 4, DGS replaced SC and SBM to provide 10% (T2), 35% (T3) or 50% (T4) DGS, DM inclusion. Mean DMI were 7.4 ± 0.5, 6.4 ± 0.1, 8.7 ± 0.4, 9.0 ± 0.4kg for T1, T2, T3 and T4. No differences ($P = > 0.05$) between treatments were observed for conception rate. CES, calf birth weight, and calf BW at A.I. were not significantly different but a numerical increase was shown with increased DGS inclusion. Significant differences were observed in cow BW and BCS where T2 < T1 < T3 < T4, and in milk production where T1 < T2 < T3 < T4. Higher ($P = 0.001$) DMI were observed for T3 and T4 than for T1 and T2. These data found that cows fed 35–50% of their diet as DGS consumed more DM and had increased BW, BCS, and milk production vs. cows fed to meet NRC recommendations with either DGS or SC and SBM.

Key Words: modified wet distillers grain, beef cow performance

228P Performance and reproduction measurements by yearling Katahdin ewes grazing tall fescue pastures using continuous or rotational grazing schemes: 1-year summary. E. A. Backes*[1,2], J. D. Caldwell[1], B. C. Shanks[1], M. J. Singer[1], M. D. Schulte[1], L. S. Wilbers[1], C. A. Clifford-Rathert[1], A. N. V. Stewart[1], A. K. Wurst[1], H. A. Swartz[1], D. L. Kreider[2], and M. L. Looper[2], *[1]Lincoln University, Jefferson City, MO, [2]University of Arkansas, Fayetteville.*

Grazing tall fescue [*Lolium arundinaceum* (Schreb.) Darbysh.] causes reduced growth and reproductive performance in cattle. However, these effects have not been well documented in Katahdin hair sheep. Our objectives were to determine the effects of grazing tall fescue pastures in late spring through summer, using either continuous or rotational grazing schemes, on performance and reproductive measurements by Katahdin yearling ewes. Beginning May 5, yearling Katahdin ewes (n = 25; 56 ± 1.9 kg initial body weight; 4 ± 0.15 initial BCS) were stratified by body weight and allocated randomly to one of 5 0.4-ha tall fescue pastures at a stocking rate of approximately 12 yearling ewes/ha. Treatments consisted of continuous (C; 2 replications) or 4-cell rotation (4R; 3 replications). At the initiation of the breeding season (May 19) one ram was placed within each pasture for a 40-d breeding season. Body weight at initiation and end of breeding, final body weight, total body weight gain, and ADG did not differ ($P \geq 0.62$) across treatment. Breeding, end of breeding, and final BCS, and FAMACHA scores did not differ ($P \geq 0.14$) across treatments. Body condition score and FAMACHA score change and ADG during breeding did not differ ($P \geq 0.19$) across treatments. Conception rates and number of lambs born were greater ($P \leq 0.05$) from 4R compared with C. Therefore, rotationally grazing tall fescue pastures in the spring through summer may not improve Katahdin yearling ewe performance, but may increase conception rates and number of lambs born.

Key Words: reproduction, rotation, yearling Katahdin ewes

229P Effects of prepartum distillers grains supplementation on subsequent steer feedlot performance. T. B. Wilson*, D. W. Shike, D. B. Faulkner, A. R. Schroeder, T. G. Nash, and F. A. Ireland, *University of Illinois, Urbana.*

Mature, fall-calving Angus and Angus × Simmental cows (n = 260) were blocked by breed, then randomly allotted to 6 groups; resulting in 12 groups total. Cows were placed on one of 2 dietary treatments: control (CON) cows not offered prepartum supplement, or prepartum supplementation (SUP) of 2.1 kg DM/head/d dried distillers grains plus solubles (DDGS) offered daily. For SUP cows, the supplementation period was 60d prepartum to calving. Both treatments were grazed on mixed tall fescue/red clover pastures of similar size and forage availability. Following calving, cows of both treatments were comingled in pastures without supplementation. Cows calving more than 30d after expected calving date were removed from study. Subsequent steer progeny (n = 78; 38 CON, 40 SUP) were weaned at an average of ± 14d of age and transitioned to a common feedlot diet with individual feed intake monitored using GrowSafe. During the feedlot phase, compositional ultrasound was used to target final 12th rib fat thickness (BF) at 1.1 cm; resulting in steers being harvested at a commercial facility in 3 groups with equal treatment representation in each group. Steer weaning BW and final BW were not different ($P \geq 0.18$). Days on feed were not different ($P = 0.79$) across treatments. As a result, no difference ($P = 0.68$) was observed in feedlot ADG. Feedlot DMI was not different ($P = 0.64$) between CON and SUP progeny; therefore, no difference ($P = 0.93$) was observed in feedlot G:F. Calf health was monitored in the feedlot with no differences ($P \geq 0.31$) in

mortality, morbidity, or bovine respiratory disease. Also, HCW, LMA, BF, marbling score, yield grade, or KPH were not different ($P \geq 0.29$) across treatments. No differences in quality or yield grade distribution were observed ($P \geq 0.13$). Late gestation supplementation of DDGS at low levels to fall-calving cows grazing fescue/clover pastures does not affect subsequent calf feedlot performance.

Key Words: cow, supplementation, gestation, fetal programming

230P Evaluation of supplemental protein source and endophyte infection on growing calf performance grazing stockpiled tall fescue. W. A. Moore*, D. J. Fennewald, C. C. Stith, and W. J. Sexten, *University of Missouri, Columbia.*

Crossbred steers and heifers (259.6 ± 27.1 kg) were used during autumn of 2009 (n = 57) and 2010 (n = 48) to evaluate supplementation, supplemental protein source and endophyte infection on calf performance. Using a completely randomized design cattle were stratified by weight and sex and allotted to a 3 ×2 factorial arrangement with 3 dietary treatments and 2 endophyte infection levels. Four or 5 calves were assigned to a pasture replicate with 2 replicates per treatment combination each year. Dietary treatments were non-supplemented control (C), supplement balanced for post-ruminal amino acid needs at 0.91 kg/d ADG (BAL), or non-balanced (NON). Supplements were offered at 0.75% BW/d (DM basis) with either 38% CP dried distillers grains plus solubles (DDGS) and SoyPlus (BAL) or 38% CP DDGS (NON). Pasture DM was allocated at 3.0% $BW \cdot hd^{-1} \cdot d^{-1}$ in 3.5 d allocations. Treatment pastures were either > 80% (H) or < 30% (L) endophyte infected tall fescue. Supplemented calves had greater ($P < 0.0001$) ADG (0.94 kg/d) than C (0.31 kg/d) with no difference ($P > 0.10$) in ADG by supplement type. Endophyte infection reduced ADG ($P = 0.004$) by 0.13 kg/d. Following the 2010 grazing period, cattle (n = 48) were placed in a feedlot and fed a common corn-based, no-roughage diet. 70 d finishing ADG was greater ($P < 0.05$) for C (1.92 kg/d) than supplemented (1.62 kg/d) and for BAL (1.71 kg/d) compared with NON (1.54 kg/d). After 124 d on finishing diet no differences ($P > 0.10$) were observed between C and supplemented steers however ADG was greater ($P = 0.03$) for BAL (1.95 kg/d) than NON (1.74 kg/d). C were more ($P < 0.05$) efficient than supplemented calves during the finishing period with no difference ($P > 0.05$) between BAL and NON. No difference ($P > 0.05$) in steer carcass weight, ribeye area, marbling score, or calculated yield grade was observed. Pasture growing phase ADG was improved by supplementation, balancing post-ruminal AA during pasture growing phase did not improve pasture ADG however feedlot ADG was increased.

Key Words: beef, supplement, amino acid, stockpile fescue

231P Influence of ENDOVAC-Bovi vaccine on feedlot steer performance. R. M. Harvey* and M. S. Kerley, *Divisions of Animal Sciences, University of Missouri, Columbia.*

Maintaining gut health of feedlot cattle is crucial for cattle to reach optimum performance potential. Reducing overgrowth of pathogenic bacteria and subsequent endotoxin production in the rumen of cattle could result in a decrease in energy expenditures by the gut tissues and hypothetically improve feed efficiency and/or enhance average daily gain. An animal′s immune system can be activated to induce a response against pathogenic microbes such as gram-negative bacteria and the consequent production of endotoxins using existing vaccine technology. Objective of this study was to determine if vaccination would improve performance of feedlot steers. Sixty Angus-crossbred steers were placed on an 84-d trial to determine influence of ENDOVAC-Bovi with Immune Plus (IMMVAC vaccine, IMMVAC Inc., Columbia, MO) on steer performance. Thirty steers were assigned to treatment group 1 which did not receive IMMVAC vaccine and 30 steers were assigned to treatment group 2 and were administered the IMMVAC vaccine. Steers in treatment group 2 were dosed with 2mL intramuscularly (IM) of vaccine 3 weeks before the start of experiment and received a 2-mL IM booster on 1-d of trial. Control animals were administered similar dosages of carrier placebo. GrowSafe feed intake system was used to measure individual steer feed intake. Residual feed intake ($P = 0.03$) was different among steers that were vaccinated and those that were not (−0.21 and 0.20, respectively). Vaccinated steers had improved ($P = 0.03$) feed efficiency by 9.4% compared with non-vaccinated steers. Average daily gains for vaccinated steers was 2.12 Kg and non-vaccinated steers was 2.04 Kg ($P = 0.41$). Dry matter intake tended to be different for vaccinated vs. non-vaccinated steers ($P = 0.14$) at 12.18 and 12.64 Kg, respectively. Carcass measurements were not different between treatments. Daily feeding behavior between treatments was not different. We concluded that immune modulation against gram-negative bacteria and endotoxins production resulted in improved performance by feedlot steers.

Key Words: feedlot, bacteria and immune stimulant vaccine, residual feed intake

232P Protein supplementation during the last third of pregnancy increases uterine blood flow in the beef cow. C. A. Zimprich*, L. E. Camacho, M. L. Bauer, and K. A. Vonnahme, *Department of Animal Sciences, North Dakota State University, Fargo.*

Other laboratories have demonstrated that maternal protein supplementation during late gestation enhances productivity of calves after birth. We hypothesized that protein supplementation during the last third of gestation would increase uterine blood flow (BF) in beef cows. To determine effects of protein supplementation during late gestation on uterine BF, 11 multiparous pregnant beef cows were fed individually and consumed low quality grass hay (~6% CP) at 2% of BW daily. Control (CON; n = 6) cows received no supplementation, whereas treated cows received a distillers dried grains-based supplement (PROT; n = 5) at 0.17% of BW daily beginning at 190 d of gestation. Uterine artery BF was determined by Doppler ultrasonography on d 190, before supplementation (baseline) and every 14 d until d 246 of gestation. Measurements included resistance index (RI), pulsatility index (PI), maternal heart rate (HR), and uterine BF for both the gravid and non-gravid horns, total BF (gravid + non gravid horns BF). There were no protein supplementations by day interactions ($P > 0.15$) on uterine BF, HR, or resistance indices. There was no effect ($P > 0.27$) of protein supplementation or day of gestation on RI for either horn. While PI of the gravid and non-gravid horns decreased ($P < 0.04$) as pregnancy advanced, only PI of the gravid horn tended to decrease ($P = 0.08$) in PROT vs. CON cows. Maternal HR increased ($P < 0.03$) as gestation progressed. Uterine BF increased ($P < 0.01$) in both gravid and non-gravid horns as gestation advanced, and therefore total uterine BF increased ($P < 0.01$). Total uterine BF was increased ($P = 0.03$) in PROT vs. CON cows (7.4 vs. 5.9 ± 0.6 L/min). The reported enhanced offspring performance may be due to increased nutrient availability to the offspring because of the greater uterine BF. While the specific mechanism for how protein supplementation increases uterine blood flow is unknown, determining the relationship between the amount and timing of protein supplementation and offspring performance may enhance management practices.

Key Words: uterine blood flow, protein supplementation, cow

233P Effects of maternal dietary energy source during mid- to late-gestation on circulating maternal hormones and metabolites in ewes. M. A. Berg*[1], J. S. Luther[2], J. L. Susko-Parrish[1], R. L. Burgett[1], and A. E. Radunz[1], *[1]University of Wisconsin, Madison, [2]University of Wisconsin, River Falls.*

Mature pregnant multiparous Polypay ewes (n = 14) were used in a randomized complete block design to evaluate the effects of maternal dietary energy source on circulating hormones and metabolites at mid and late gestation. From 67 to 121 ± 3 d of gestation, ewes were individually penned and fed 1 of 3 diets formulated to contain 3.52 Mcal ME/d with the major energy source coming from alfalfa haylage (HL), corn (CN), or dried corn distillers grains plus solubles (DG). Ewe BW and BCS were collected weekly and DMI was adjusted to maintain similar BW gain for ewes fed CN and DG vs. HL. Jugular blood samples were collected before feeding on d 79, 93, 107 and 121 of gestation, and at 3 and 6 h after feeding on d 93 and 121 of gestation. Plasma concentrations of glucose, insulin, progesterone, blood urea nitrogen, NEFA, and β-hydroxybutyric acid were analyzed. Pre-feeding plasma glucose, insulin, and progesterone concentrations were similar ($P \geq 0.25$) among treatments. On d 93, plasma glucose concentrations were not influenced ($P = 0.94$) by maternal energy source. However, plasma insulin concentrations for ewes fed DG were greater ($P = 0.03$) at 6 h post feeding when compared with CN ewes, while insulin concentrations in HL ewes remained similar. On d 121, plasma glucose concentrations were greater ($P = 0.03$) at 3 h post-feeding for ewes fed DG vs CN and HL energy sources. Plasma insulin concentrations within hr on d 121 were greater ($P = 0.005$) at 3 h for DG vs CN, but were similar to HL. When feeding DG as an energy source during mid-gestation, plasma insulin concentrations are elevated post-feeding relative to CN, but plasma glucose concentrations are not affected. However, in late-gestation both plasma glucose and insulin concentrations are elevated post-feeding for ewes fed DG as an energy source when compared with CN.

Key Words: energy source, gestation, sheep

234P Effects of injectable vitamin and selenium on serum vitamin and selenium concentrations and growth performance in beef calves. P. L. Steichen*[1,2], B. W. Neville[2], S. I. Klein[1], R. L. Stuart[3], and C. R. Dahlen[1], *[1]Department of Animal Sciences, North Dakota State University, Fargo, [2]North Dakota State University Central Grasslands Research Extension Center, Streeter, [3]Stuart Products Inc., Bedford, TX.*

Crossbred beef calves (n = 40; 3–20 d of age) were used to determine the effects of injectable vitamins on serum concentrations of selenium (Se), vitamins A (VitA) and E (VitE), and ADG. Calves were randomly assigned to treatments in a 2 × 2 factorial design: 1) administration or not of 4 mL BoSe (1 mg Se and 68 IU VitE/mL); 2) administration or not of 5 mL of VITAL E-A+D (VITAL-EAD; 300 IU VitE, 100,000 IU VitA, and 10,000 IU VitD/mL). Blood samples were taken from calves before treatment (d 0) and at d 2 and calf BW were taken on d 0 and d 23. Blood samples were collected from dams on d 0 and all cow/calf pairs were maintained in a single dry lot pen and fed once daily (47% corn silage, 37% hay, 11% barley, and 5% liquid supplement, DM basis). Serum samples were analyzed for Se, VitA, and VitE. Mean concentrations of Se, VitA, and VitE in the dams were 112.8 ± 2.09 ng/mL, 0.21 ± 0.01 µg/mL, and 2.84 ± 0.11 µg/mL, respectively. No interactions ($P > 0.10$) were present among BoSe and VITAL-EAD factors for serum concentrations of Se, VitA, or VitE in calves on d 2. However, calves treated with BoSe (72.5 ± 1.73 ng/mL) had greater ($P < 0.01$) concentrations of Se on d 2 compared with calves not given BoSe (56.3 ± 1.68 ng/mL). Calves treated with VITAL-EAD had greater ($P < 0.01$) concentrations of VitA (0.22 ± 0.01 µg/mL) and VitE (14.8 ± 1.33 µg/mL) on d 2 compared with calves not given VITAL-EAD (0.16 ± 0.01 µg/mL and 4.73 ± 1.33 µg/mL for VitA and VitE, respectively). Concentrations of VitE in calves on d 0 were correlated (0.451; $P < 0.01$) with calf BW, whereas concentrations of Se in cows were correlated with days postpartum (0.314; $P < 0.05$). Calf ADG was affected by an interaction among BoSe and VITAL-EAD ($P = 0.01$). Calves given either BoSe (0.75 ± 0.06 kg/d) or VITAL-EAD (0.75 ± 0.06 kg/d) had greater ($P < 0.01$) ADG compared with calves given both products (0.53 ± 0.07 kg/d), whereas untreated calves were intermediate (0.64 ± 0.06 kg/d). Administration of VITAL-EAD increased serum concentrations of VitA and VitE in young beef calves whereas BoSe increased concentrations of Se.

Key Words: beef calves, selenium, vitamin A, vitamin E

235P Identification of risk factors that cause milk fat depression of cows consuming dried distillers grains plus solubles. H. A. Ramirez Ramirez* and P. J. Kononoff, *University of Nebraska, Lincoln.*

Twenty Holstein cows, 12 primiparous and 8 multiparous, with (mean ± SD) 117 ± 17 DIM and 641 ± 82 kg were randomly assigned to one of 4 dietary treatments in replicated 4 × 4 Latin Squares to test the effects of fat and starch as risk factors associated with milk fat depression to a diet containing dried distillers grains with solubles (DDGS). In formulating the experimental diets, corn oil was added to increase the level of fat in the diet and ground corn was used to increase the starch content of the diet. In each 21-d period cows were assigned to one of 4 dietary treatments: control ration containing 30% DDGS but no risk factors associated with milk fat depression (CONT; EE 5%, starch 21%); with added corn oil (OIL; EE 6%, starch 21%); CONT with added starch (STARCH; EE 5%, starch 27%); and CONT with added corn oil and starch (COMB; EE 6%, starch 26%). Dry matter intake was similar across treatments (22.2 ± 0.63 kg/d). Milk yield, milk protein percentage and milk protein yield were similar across treatments averaging 26.6 ± 1.01 kg/d, 3.2 ± 0.05% and 0.84 ± 0.03 kg/d, respectively. Fat corrected milk (3.5% FCM) was greater ($P <$ 0.01) for CONT (26.5 ± 1.12) and no differences were detected among the remaining treatments averaging 23.5 ± 1.12 kg/d. Milk fat percentage was greatest ($P < 0.01$) when cows consumed CONT (3.3 ± 0.15%), OIL and STARCH were intermediate (3.0% ± 0.15%) and COMB resulted in the lowest milk fat percentage (2.73 ± 0.15%). Milk fat yield was greater for the CONT diet compared with the other 3 treatments which were similar (0.90 versus 0.75 ± 0.05 kg/d). These results demonstrate that feeding high proportions of DDGS does not cause MFD in dairy cows; however high levels of fat and starch are risk factors that will likely induce MFD in diets containing DDGS.

Key Words: fatty acids, starch, CLA

236P BFNMP$: A tool for estimating feedlot manure economics. A. K. Watson*[1], G. E. Erickson[1], T. K. Klopfenstein[1], R. K. Koelsch[1], R. E. Massey[2], J. H. Harrison[3], and M. K. Luebbe[1], *[1]University of Nebraska, Lincoln, [2]University of Missouri, Columbia, [3]Washington State University, Puyallup.*

The Beef Feed Nutrient Management Planning Economics (BFNMP$) computer program (available at http://water.unl.edu/web/manure/software) can assist producers in understanding the effects that manure handling changes could have on their operation. The BFNMP program calculates manure management economics based on animal nutrient intake, manure nutrient availability, land requirement for spreading, operating costs and fertilizer value. The objectives of this study were to look at 1) effect of dietary N and P from traditional grain based diets compared with diets including 40% distillers grains (DG) 2) effect of different N volatilization (VOL) rates 3) impact of changing manure application rates from N to P based and from 1 to 4 yr rates. While looking at different scenarios all other factors in the model remained constant. These scenarios fed out 5000 cattle per yr in 100 hd pens from 341 to 591 kg with 144 d on feed. Fertilizer was valued at $1.22/kg N, $1.49/kg P and $1.18/kg K. Increasing dietary N and P increases nutrient excretion. Capturing these nutrients in manure increases costs, but increases value at a greater rate. Manure from cattle fed a traditional feedlot diet with 50% N VOL has a value of $21.53/animal ($14.45/Mg) based on inorganic fertilizer values. Feeding a 40% DG ration results in manure worth $29.70/animal ($19.94/Mg). Decreasing N VOL to 20% increases value of the manure to $26.55/animal and $37.11/animal for the grain based and DG diet, respectively. Spreading enough manure in 1 yr to meet crop P requirements for 4 yrs costs approximately the same as spreading manure every yr to meet N requirements. Phosphorus based applications, whether 1 or 4 yrs, require about 3 times the acres of N based applications. Spreading on a 1-year P basis is expensive and unnecessary. Spreading on a N basis results in excess P buildup. Fertilizer prices have increased dramatically in recent yrs which has renewed interest in manure fertilizer and enhanced the value of manure.

Key Words: manure, nitrogen, phosphorous

237P Sow productivity can influence growth rate, efficiency, and performance of offspring. J. D. Magolski*, K. A. Vonnahme, D. J. Newman, and E. P. Berg, *North Dakota State University, Fargo.*

The objective of this study was to investigate growth rate, efficiency, and performance of offspring from sows of varying levels of productivity. Twenty-three gilts of similar genetic background were selected based on strict criteria to reduce piglet variation from 8 sows. At approximately 16 kg, gilts were assigned to individual pens and fed at 3.8% of body weight during the acclimation period. Treatments were randomly assigned based on dam and body weight (24.5 ± 3.2 kg), and included daily feedings of a 113 g beef patty from nonimplanted steers, a 113 g beef patty from steers receiving estrogenic implants, a 198 g piece of firm tofu, or a negative control that received no supplemental treatment. All gilts also received a very low estrogen base diet fed at approximately 3.8% of BW and adjusted weekly to account for changes in intake. Measurements of intake and growth included average daily gain, average daily feed intake, feed:gain ratio, days to 22.7 kg, days to 118 kg, total feed to 118 kg, and age at first heat. Accretion rate of lean and fat was evaluated through ultrasound. Gilts were slaughtered at the NDSU Meats Lab a minimum of 3 d following first visual heat, and carcass data was collected. All data was correlated with litter performance and sow lifetime productivity data, including litters/ sow/ year and pigs/ sow/ year. Data were analyzed using Proc CORR and Proc MIXED functions of SAS, with litter as a random variable. No piglet dietary treatment effect was observed within growth performance or carcass traits ($P \geq 0.27$). Litters/ sow/ year was correlated ($P \leq 0.04$) with offspring performance including days to 22.7 kg ($r = -0.73$), days to 118 kg ($r = -0.78$), and average daily gain ($r = 0.73$). Feed consumed to reach 118 kg was also correlated ($P \leq 0.04$) with average born alive ($r = 0.72$) and total born alive ($r = 0.77$). These preliminary data suggest that sow productivity influences offspring performance and efficiency, and further research of this relationship with a larger sample size could be beneficial to the swine industry.

Key Words: gilt, offspring, performance, productivity

238P Comparison of fermentation end products within continuous culture among steers differing in residual feed intake (RFI) phenotypes. N. O. Minton*, J. H. Porter, N. F. Johnson, J. G. Yoder, and M. S. Kerley, *University of Missouri, Columbia.*

Whole rumen content (WRC) was collected from steers (n = 4) previously phenotyped for residual feed intake (RFI). RFI was obtained over an 88 d feeding trial, where WRC collection occurred immedi-

ately post harvest on feed efficient (n = 2 RFI-) and inefficient (n = 2 RFI+) steers. WRC was frozen after collection at −20°C for 81 d before study. A 1:1 ratio of thawed WRC to McDougal′s artificial saliva was strained through 4 layers of cheese cloth to total 9 L of strained whole rumen content (SWRC) per steer. Fermenters (n = 24) contained 150 mL of SWRC. Treatment consisted of RFI- and RFI+ SWRC with 12 replications per treatment. Diet remained constant between FI trial and continuous culture. Fermenters were fed 25 g of diet twice daily over 7 d with sampling on d 5, 6 and 7, respectively. Fermented SWRC was monitored for pH and analyzed for VFA and ammonia production while effluent was analyzed for purines, nitrogen and organic matter to determine microbial efficiency (MOEFF) and true organic matter digestibility (TOMD). SWRC from efficient steers in comparison to inefficient steers recorded higher pH ($P < 0.01$) at 0, 4 and 8 h after feeding; respectively. SWRC from efficient steers resulted in lower total VFA production (79.72 + 1.40 vs. 90.57 + 1.40; $P < 0.001$) as well as a lower acetate to propionate ratio (1.46 + 0.02 vs. 1.60 + 0.02; $P = 0.001$) than SWRC from inefficient steers. TOMD tended to be lower for SWRC of efficient steers than inefficient steers ($P = 0.11$) while MOEFF and ammonia levels did not differ. Fermentation balance between efficient and inefficient steers calculated SWRC from efficient steers had 1.5% savings in metabolizable energy compared with SWRC from inefficient steers. A portion of energetic differences between RFI phenotypes may be explained by fermentation characteristics of the rumen microflora.

Key Words: RFI, methane, beef, fermentation

239P Effects of feeding low or high oxidized dried distillers grains with solubles (DDGS) to sows on piglet birth weight variation and litter performance. X. J. Li*[1], G. C. Shurson[1], D. D. Gallaher[1], J. E. Anderson[2], S. K. Baidoo[1,3], and L. J. Johnston[1,3], *[1]University of Minnesota, St. Paul, [2]University of Minnesota, Morris, [3]Southern Research and Outreach Center, Waseca, MN, [4]West Central Research and Outreach Center, Morris, MN.*

We hypothesized that sow diets containing DDGS with evidence of elevated oxidative damage would increase the incidence of low birth weight piglets. To test this hypothesis, an experiment was conducted to evaluate the effects of feeding sow diets containing DDGS with low or high levels of oxidative damage on variation in piglet birth weight and litter performance. Mixed parity sows (n = 40; mean parity = 3.3) were assigned randomly to 1 of 3 dietary treatments. Sows were fed either corn-soybean meal control diets (CON), or diets containing DDGS (gestation = 40%; lactation = 20%) with low oxidative damage (LOD; 1.6 ng malondialdehyde equivalent/mg oil), or high oxidative damage (HOD; 5.2 ng malondialdehyde equivalent/mg oil). Dietary treatments were imposed for one reproductive cycle. Concentrations of supplemental Se (0.30 ppm) and vitamin E (66 IU/kg) were similar among gestating and lactating diets. Individual birth weight was recorded for pigs before suckling (BS) and after suckling (AS) and data were sorted into 3 classes: small (≤1.0 kg), medium (>1.0 kg and <1.6 kg), and large (≥1.6 kg). Neither LOD nor HOD affected distribution of pigs in birth weight categories or CV of birth weight within litter AS compared with CON. For BS pigs, feeding HOD caused greater ($P < 0.05$) within litter variation in birth weight compared with CON or LOD (CV = 25.8% vs. 19.0% or 18.5%; Pooled SE = 1.67). Sows fed HOD farrowed 2.3 and 3.8 fewer ($P < 0.05$) medium-sized pigs than sows fed CON and LOD, respectively. Feeding HOD increased ($P < 0.05$) the number of large pigs born per litter compared with feeding LOD (4.7 vs. 2.3; Pooled SE = 0.64) and increased the number of stillborn pigs per litter compared with feeding CON (1.7 vs. 0.4; Pooled SE = 0.43). Dietary treatment had no effect on litter size, litter weight gain, piglet ADG, or pre-weaning mortality. In conclusion, sows fed HOD produced litters with greater variation in piglet birth weight by farrowing fewer medium-sized pigs and more large pigs, but did not affect incidence of small pigs or litter performance.

Key Words: oxidized DDGS, sow performance, litter performance

240P Influence of thermally oxidized oils and fats on growth performance and lipid profile of young pigs. P. Liu*[1], B. J. Kerr[2], T. E. Weber[2], C. Chen[1], L. J. Johnston1,3, and G. C. Shurson[1], *[1]University of Minnesota, St. Paul, [2]USDA-ARS, Ames, IA, [3]West Central Research and Outreach Center, Morris, MN.*

One hundred two barrows (~6.7 kg BW) were used to investigate the effects of feeding corn-soybean meal diets containing thermally oxidized oils and animal fats on growth performance and lipid profile. Pigs were assigned to dietary treatments in a 4 × 3 factorial design. Main effects were lipid source [corn oil (C), canola oil (CA), poultry fat (PF), and tallow (TL)] and oxidation level [original lipids (OL), slow oxidation (SO) of lipids heated for 72 h at 95°C, or rapid oxidation of lipids (RO) heated for 7 h at 185°C]. Pigs were provided ad libitum access to diets containing 10% added lipid for 28 d, followed by controlled feed intake (4% BW) for 10 d. After a 28-d ad libitum feeding period, pigs fed RO lipids had lower BW (12.93 vs. 14.63 kg, $P < 0.05$), tended to have lower ADFI (353 vs. 418 g/d, $P = 0.09$), and had reduced ADG (228 vs. 285 g/d, $P < 0.05$) compared with pigs fed OL. Pigs fed CA had reduced G:F (0.59 vs. 0.68, 0.67, and 0.68, $P < 0.05$) compared with those fed CN, PF, and TL. Hepatosomatic index of pigs fed RO lipids tended to increase ($P = 0.09$) compared with those fed OL. Pigs fed SO or RO lipids had decreased ($P < 0.05$) liver triglyceride (TG) level compared with those fed OL. The lower liver TG levels in pigs fed SO and RO was consistent with higher ($P < 0.05$) mRNA expression of PPARα target genes (ACO, CPT-1, and mHMG-CoA-S) in those fed SO and RO compared with OL. Pigs fed either CN or CA tended to have increased ($P = 0.09$) liver TG level compared with those fed TL. Liver cholesterol (CL) concentration in pigs fed CN diets was lower (1,914 vs. 2,050 μg/g, $P < 0.05$) than those fed PF diets, and tended to be lower (1,914 vs. 1,987 μg/g, $P = 0.06$) than those fed TL diets, whereas pigs fed CA diets had decreased (1,673 vs. 2,050 and 1,987 μg/g, $P < 0.05$) liver CL concentration compared with those fed PF or TL diets. In conclusion, feeding high temperature treated oxidized lipids negatively affected growth performance and lipid profile of young pigs, as indicated by a decrease in ADFI and ADG, a higher hepatosomatic index, and lower hepatic tryglyceride concentrations.

Key Words: oxidized lipids, growth performance, lipid profile, pigs

241P Effects of β-mannanase on metabolizable energy of feedstuffs fed to growing pigs. G. Voilqué*, Y. Zhao, and S. W. Kim, *North Carolina State University, Raleigh.*

This study was to determine the effects of supplemental β-mannanase (CTCZYME at 0.1% providing 800 U/kg of feed, CTCBIO, Korea) on ME in barley (n = 6), copra meal (n = 6), corn (n = 8), DDGS (n = 10), palm kernel meal (n = 6), sorghum (n = 4), soybean meal (n = 8), and wheat (n = 6) using 54 barrows (20.6 ± 0.6 kg) in individual metabolism crates (1.32 × 0.45 m) with stainless steel feeders, water nipples, screens and trays that allow separate collection of feces and urine. Barrows were allotted to replicated 2 × 2 Latin squares with 2 treatments (0 or 0.1% CTCZYME) and 2 periods. Each period was consisted of 4 d adjustment, 3 d collection, and 1 d transition. Pigs

were fed the experimental diets at 0.09 × $BW^{0.75}$ kg daily. Chromic oxide was used on d 4 and 7 as an indicator of initiation and termination of fecal sampling. Urine was also collected for 3 d. The weight of feces and the volume of urine were measured daily. Fecal samples were dried at 55°C whereas urine samples were weighed and dried in a freeze dryer. The weights of dried feces and urine were recorded to calculate dry matter %. Dried fecal samples were ground in a commercial blender. Dried urine samples were store at 4°C. The GE contents of test ingredients, experimental diets, dried feces, and dried urine were determined in duplicate by adiabatic bomb calorimeter. Metabolizable energy in barley (3,218 vs. 3,553 kcal/kg, $P < 0.05$), copra meal (3,048 vs. 3,161 kcal/kg, $P = 0.06$), corn (3,247 vs. 3,241 kcal/kg, $P = 0.92$), DDGS (3,548 vs. 3,566 kcal/kg, $P = 0.77$), palm kernel meal (2,751 vs. 3,091 kcal/kg, $P < 0.05$), sorghum (3,316 vs. 3,505 kcal/kg, $P = 0.05$), soybean meal (3,335 vs. 3,432 kcal/kg, $P < 0.05$), and wheat (3,197 vs. 3,207 kcal/kg, $P = 0.64$) with 0 or 0.1% CTCZYME were obtained. The use of β-mannanase enhanced ($P < 0.05$) the ME values in barley, palm kernel meal, and soybean meal, and tended to enhance ($P < 0.10$) the ME values in copra meal and sorghum, whereas did not affect ($P > 0.10$) the ME values in corn, DDGS, and wheat.

Key Words: β-mannanase, feedstuffs, metabolizable energy, pigs

242P Effect of modified distillers grains with solubles and crude glycerin in finishing diets on fatty acid composition and oxidation of fresh beef. K. M. McClelland*, J. P. Jaderborg, D. M. Paulus, J. M. Popowski, G. I. Crawford, A. DiCostanzo, and R. B. Cox, *University of Minnesota, St. Paul.*

Crossbred steers and heifers (n = 48) were assigned randomly to one of 4 treatment groups and fed individually using a Calan gate feeding system. Treatments were arranged in a 2 × 2 factorial design as follows: traditional steam flaked corn diet with no modified distillers grains with solubles or glycerin (CON); CON with 35% modified distillers grains with solubles (MDGS); CON with 10% glycerin (GLY); and CON with 35% MDGS and 10% glycerin (MDGS/GLY). Crude glycerin and MDGS inclusion was in the place of steam flaked corn in the MDGS, GLY, and MDGS/GLY treatments. At a mean weight of 590 kg, cattle were humanely harvested at a commercial abattoir in 2 groups. Shoulder clods were removed from the right side of each carcass 48 h post mortem, vacuum packaged, and stored refrigerated. Backfat samples (50 g) were taken from the 12th rib for fatty acid analysis. Shoulder clods were ground individually, twice through a 0.375-cm grinder plate. Ground beef was placed on a tray, overwrapped and stored for 8 consecutive d at 4°C under cool white fluorescent lighting. Samples of ground beef (50 g) were collected on d 0 and 7 for thiobarbituric acid reactive substances (TBARS) testing. A subset of 3 samples per treatment (n = 12) were selected for fatty acid composition and TBARS testing in duplicate. Treatment had no effect any specific fatty acid ($P > 0.05$), however did show a trend ($P = 0.06$) with MDGS having a greater percentage of C18:2 than CON. Additionally, there were no differences between treatments for SFA ($P = 0.99$) and MUFA ($P = 0.53$), however there was a trend for PUFA ($P = 0.06$) with MDGS having a greater percentage than CON. No differences were shown between treatments for TBARS values on d 0 or 7 ($P = 0.59$ and 0.49, respectively). Results indicate that the addition of MDGS and crude glycerin in beef cattle finishing diets does not affect fatty acid composition or lipid oxidation in fresh beef.

Key Words: beef, fat, glycerin, distillers

243P Synergistic effects of β-adrenergic agonists and zinc supplementation. A. A. Baer*, J. C. Jones, K. A. Jones, and A. C. Dilger, *University of Illinois, Urbana.*

β-Adrenergic agonists (βAA) are known to improve feed efficiency and ADG in livestock. Some reports have suggested that the effects of βAA are enhanced with supplemental zinc, but these reports are unclear. The effects of clenbuterol and supplemental zinc were tested in mice, and the effects of ractopamine (RAC) and supplemental zinc were tested in pigs. Both experiments were designed as a 2 × 2 factorial arrangement; factors were βAA and supplemental zinc inclusion. Six-week old male mice (n = 40) were fed 150 mg peanut butter treats containing clenbuterol (0 or 0.15 mg/day) and Zinpro200 (0 or 0.75 mg/day). Body and food weights were measured on d 0, 3, 5, 7 and 10, and mice were sacrificed on d 10. Body weight, empty carcass weight, dressing percentage, ADG, and G:F were measured. Data were analyzed with the Mixed procedure of SAS using a model including the fixed effects of βAA inclusion, zinc inclusion, and their interaction. As expected, mice fed clenbuterol had improved growth rate and increased carcass weight compared with control. Zinc supplementation had no effect on growth rate, food intake or carcass weight. No interaction occurred between clenbuterol and supplemental zinc for any of the measurements. In pigs, 4 pens of 8 gilts each were fed Paylean-9 (0 or 7.4 mg/kg) and AvailaZn100 (0 or 500.4 mg/kg) for 5 weeks before slaughter. Body and feed weights were taken at d 0, 17, and 35 to estimate ADG, feed intake, and G:F. The 4 gilts closest to the mean BW of each pen were selected for slaughter (mean BW = 123 kg). Carcass quality measurements and primal yields were collected. RAC-treated gilts had greater BW (d 17 and 35) and carcass weight, higher dressing percentage, and increased ham and shoulder weights compared with controls. The effect of zinc supplementation was not significant for any trait measured; however, zinc supplementation alone increased G:F estimates by 10% when compared with control. Gilts fed both RAC and zinc had lower BW (d 35) and less total primal weights than those fed only RAC. The results of both studies suggest that zinc supplementation in addition to βAA treatment is not advantageous to either mice or gilts.

Key Words: β-adrenergic agonist, zinc, pig, mice

244P Effects of sorghum grain and sorghum dried distillers grains with solubles on the composition, quality, and sensory attributes of ground pork. G. R. Skaar, T. A. Houser*, R. D. Goodband, B. L. Goehring, A. Stickel, B. M. Gerlach, K. Steele, and K. M. Sotak, *Kansas State University, Manhattan.*

A total of 288 finishing pigs (PIC TR4 × 1050, initially 58.9 kg) were utilized in a 73 d feeding study to determine the effects of sorghum dried distillers grains with solubles (S–DDGS) in sorghum- or corn-based diets on ground pork quality. The dietary treatments included: sorghum-based diets with 0, 15, 30, or 45% S-DDGS, a sorghum-based diet with 30% corn DDGS (C-DDGS) and a corn-based diet with 30% C-DDGS. Shoulders from 24 barrow and 24 gilt carcasses were ground and evaluated for proximate and fatty acid composition, iodine value (IV), objective color, thiobarbituric acid-reactive substances (TBARS), and sensory attributes. Finishing diet and gender did not interact to affect composition, fatty acid profile, color or TBARS ($P > 0.05$). Pork from gilts contained less fat and more moisture ($P < 0.001$), was less saturated with a greater IV and total percentage of PUFA ($P < 0.01$), and also had a lower L* value ($P < 0.001$) and higher a* value ($P = 0.006$) than pork from barrows. Gender did not affect total color change (ΔE) from 0 to 120 h ($P = 0.30$), TBARS ($P = 0.08$), or sensory attributes ($P \geq 0.32$). Finishing diet had no affect on total fat, moisture, or protein composition ($P \geq 0.18$). Increasing S-DDGS resulted in a linear ($P < 0.001$) decrease in SFA and MUFA and an increase ($P < 0.01$) in PUFA and ground pork IV. Pork from pigs fed 30% S–DDGS had a greater percentage of MUFA ($P = 0.01$) and a lower percentage of PUFA ($P > 0.006$) and reduced IV ($P = 0.03$) compared with pork from pigs fed the sorghum-based diet with 30% C-DDGS. Diet did not affect TBARS ($P = 0.37$) or L*, a*, or b* values ($P \geq 0.11$) but was shown to influence ΔE ($P = 0.01$) with pork from pigs fed sorghum grain and 30% S-DDGS having less total change than all other treatments. It is concluded that consumers will not be able to differentiate pork from pigs fed DDGS and that feeding sorghum grain and S-DDGS can be done to result in high quality ground pork.

Key Words: dried distillers grains with solubles, gender, pork quality, sorghum

245P Can DNA marker technology improve feedlot growth promotion management decisions to ultimately improve the consumer's beef eating experience? K. M. Thompson*[1], J. J. Wagner[1], T. G. O'Quinn[1], D. R. Woerner[1], T. E. Engle[1], R. K. Peel[1], J. K. Ahola[1], B. W. Woodward[2], and M. N. Streeter[3], *[1]Department of Animal Science, Colorado State University, Fort Collins, [2]Merial Limited, Duluth, GA, [3]Merck Animal Health, DeSoto, KS.*

Yearling steers (n = 360 selected from 1,100 contemporaries) were used to evaluate if the IGENITY profile could sort cattle into tenderness and marbling outcome groups, and to determine if interactions exist between tenderness, marbling, and growth promotion strategy. Factors evaluated in a 2 × 2 × 2 factorial arrangement were: 1) tenderness genotype (tender vs. tough); 2) marbling genotype (high vs. low); and 3) growth promotion strategy (GP, aggressive – Revalor-XS implant, 20 d Zilmax vs. moderate – Revalor-IS initial and re-implant, no Zilmax). High tenderness genotype steers were heavier ($P < 0.05$) initially and at harvest, had greater ($P < 0.05$) DMI and lower ($P < 0.05$) LM Warner-Bratzler shear force (WBSF) vs. low tenderness genotype steers. High marbling (HIMF) genotype steers were heavier ($P < 0.001$) initially and at harvest, had greater ($P < 0.05$) ADG, DMI, HCW, and marbling score, and tended to have greater fat depth ($P < 0.06$) and less desirable yield grade (YG, $P < 0.09$) when compared with low marbling (LIMF) genotype steers. Aggressive GP steers tended to be heavier ($P < 0.06$) at harvest, had greater ($P < 0.05$) ADG, G:F, recovered NEm and NEg, HCW, dressing percentage, LM area, WBSF, and a more desirable ($P < 0.05$) YG vs. moderate GP steers. No interactions between marbling and tenderness genotypes were found and the effects of GP were independent of tenderness genotype. However, interactions between marbling genotype and GP for ADG, G:F, and NE recovery from d 107 through harvest on d 140 or 154 suggest that the ADG and G:F response to Zilmax was slightly lower for the HIMF steers as compared with the LIMF steers. Yearling steers can be effectively sorted into marbling and tenderness groups using the IGENITY profile regardless of growth management strategy.

Key Words: growth promotants, genotype, marbling, tenderness

246P Predicting beef tenderness using multispectral image texture features. X. Sun*, K. Maddock Carlin, V. L. Anderson, A. N. Lepper, C. A. Schwartz, W. L. Keller, B. R. Ilse, J. D. Magolski, and E. P. Berg, *North Dakota State University, Fargo.*

The objective was to investigate the usefulness of raw meat surface texture using different wavelengths to predict cooked beef tenderness. Texture features (88 gray level co-occurrence, 81 fast Fourier transform, and 48 Gabor wavelet filter texture features) were extracted from multispectral images (440, 550, 710, and 810 nm) of beef steaks obtained using a CCD camera (Model CoolSNAPES; Roper Scientific Inc.) attached to a multispectral imager system (MultiSpec Imager; Optical Insights). Images were obtained from 2.54-cm thick cross-sectioned steaks cut from longissimus thoracis (tender n = 109, tough n = 26), semimembranosus (tender n = 72, tough n = 53), biceps femoris (tender n = 73, tough n = 7), and supraspinatus (tender n = 64, tough n = 31) muscles. Steaks were classified as tough or tender based on Warner-Bratzler shear force values whereby ≤4.0 kg was considered tender. Texture features were submitted to STEPWISE multiple regression and support vector machine (SVM) analysis to establish prediction models for tenderness. Subsamples (80%) of tender and tough classified steaks were used to train the SVM or establish the STEPWISE models which were then validated on the remaining 20% of the steaks. Both models using multispectral image features at each of the 4 wavelengths classified tenderness of biceps femoris steaks with 77% accuracy. STEPWISE models (440 and 810 nm) were 80% correct in predicting tenderness of longissimus thoracis. Tenderness of semimembranosus steaks was predicted with an accuracy of 85% (440 nm), 80% (810 nm), and 70% (550 nm) using STEPWISE models and 75% (440 nm) and 65% (810 nm) using SVM models. STEPWISE and SVM models were ≤65% accurate in predicting tenderness of supraspinatus steaks. In conclusion, STEPWISE models (440 nm and 810 nm) predicted tenderness of 3 beef cuts with an accuracy of approximately 80%, while SVM models were less predictive of tenderness. Both models were considerably less accurate in classification of designated tough steaks. Multispectral texture features isolated through the development of SVM and STEPWISE models show potential as a means to predict tenderness of beef steaks.

Key Words: beef, tenderness, SVM, multispectral image texture features

247P Effect of high and low levels of urea in beef cattle finishing diets on shelf life stability of fresh strip steaks. K. M. McClelland*, J. E. Johnston, I. Ceconi, G. I. Crawford, and R. B. Cox, *University of Minnesota, St. Paul.*

Crossbred steers (n = 42) were assigned randomly to 1 of 3 treatment groups and fed individually using a Calan gate feeding system. Treatments included a dry rolled corn based control with no added urea (CON); CON with 0.4% urea DM (LOW); and CON with 0.6% urea DM (HIGH). All diets contained 20% dried distillers grains (DM basis). At a mean weight of 590 kg, steers were humanely harvested at a commercial abattoir and 48 h postmortem, strip loins were removed from the right side of each carcass, vacuum packaged, and transported refrigerated to the University of Minnesota Meats Laboratory for further analysis. Strip loins were weighed before and after package removal to calculate purge loss. Objective fat color scores (L*, a*, and b*) were taken at 4 locations along the dorsal edge of each strip loin before steak removal. Three 2.54-cm steaks were cut serially from the anterior end of each strip loin for further analysis. One steak was weighed, suspended for 24 h at refrigerated temperature and isolated atmosphere, and then re-weighed to calculate drip loss percentage. Two steaks were placed on polystyrene trays, overwrapped with PVC, and stored at 4°C under cool white fluorescent lighting for 7 d. Objective color values (L*, a*, and b*) and subjective color scores (lean color, surface discoloration, and overall appearance evaluated by an 8 person trained panel) were recorded daily for 7 consecutive days. Treatment did not affect purge loss percentage ($P = 0.60$) or drip loss percentage ($P = 0.98$). Additionally, there were no differences in objective color values (L*, $P = 0.26$; a*, $P = 0.39$; b*, $P = 0.17$), subjective color scores (lean color, $P = 0.42$; surface discoloration, $P = 0.77$; overall appearance, $P = 0.45$) or fat color measurements (L*, $P = 0.11$; a*, $P = 0.41$; b*, $P = 0.50$). Results from this study indicate that the addition of urea at low or high inclusions in beef cattle finishing diets does not negatively affect shelf life stability of fresh beef strip steaks.

Key Words: beef, urea, steak

248P Effects of frequent introduction and removal of dried distillers grains with solubles (DDGS) in growing-finishing swine diets on backfat fatty acid composition. K. M. McClelland*[1], A. M. Hilbrands[2], L. J. Johnston[2], G. C. Shurson[1], and R. B. Cox[1], *[1]University of Minnesota, St. Paul, [2]West Central Research and Outreach Center, Morris, MN.*

Crossbred pigs (n = 216; BW = 51.3 ± 3.1 kg) were assigned randomly to one of 4 dietary treatments to evaluate the effects of switching between diets with or without DDGS during the growing-finishing phase on fatty acid composition of backfat. Treatments included a corn-soybean meal control diet with 0% DDGS (CON); CON with 20% DDGS (D20); CON and D20 diets alternated bi-weekly (D20S); and CON with a diet containing 40% DDGS alternated bi-weekly (D40S). Diets were fed in 3 phases. For D20S and D40S, there were 5 2-week feeding periods during the feeding trial and pigs started and ended the trial consuming DDGS. Pigs were harvested (BW = 112 kg) at a commercial abattoir and backfat samples (n = 80) were removed from the loin adjacent to the 10th rib 24 h postmortem and evaluated for fatty acid composition. Dietary treatment had no effect on C14:0, C18:3, C20:0, or C22:0, but CON pigs had higher concentrations of C16:0 than pigs in the D20S ($P = 0.005$) and D40S ($P < 0.001$) diets (27.8, 26.7, 26.5%). Pigs fed CON had a higher percentage of C18:0 than those fed D20 ($P = 0.02$) and D40S ($P = 0.007$; 16.5, 15.1, 14.8%). Feeding CON and D20 resulted in higher C18:1 percentages than D20S ($P < 0.0001$ and $P < 0.004$, respectively) and D40S ($P < 0.0001$ and $P < 0.002$, respectively; 41.5, 40.7, 39.3, 39.1%). As expected, pigs fed CON had lower C18:2 concentrations than pigs from all other treatments ($P < 0.001$; 11.3, 14.5, 16.4, 17.1%). Interestingly, D20 pigs had lower C18:2 concentrations than D20S ($P = 0.004$) and D40S ($P < 0.001$) pigs. Compared with all other treatments, pigs fed CON had higher total saturated fatty acid concentrations (SFA; $P = 0.005$), as well as lower unsaturated fatty acids (UFA; $P < 0.001$) and polyunsaturated fatty acids (PUFA; $P < 0.0001$). Similar to C18:2 results, pigs fed D20 had lower PUFA concentrations than D20S ($P = 0.005$) and D40S ($P < 0.001$) pigs. These results indicate that bi-weekly alternating between corn-soybean meal and 20 or 40% DDGS diets results in higher C18:2 and PUFA concentrations in backfat compared with feeding 20% DDGS diets continuously during the grower-finisher period.

Key Words: pork, fat, DDGS

249P An evaluation of pelvic bone shape in beef carcasses. J. Hosch*, C. Calkins, K. Varnold, L. Senaratne-Lenagala, and J. Hergenreder, *University of Nebraska, Lincoln.*

Pelvic bones from the right side of 20 5 beef carcasses were collected and analyzed to characterize the variation in bone shape. Two heifer and 2 steer carcasses were selected from each of the following weight ranges: 272–318, 319–363, 364–408, 409–454, and >455 kg. After round fabrication and collection of boneless cuts, 2 pieces of the pelvis were obtained - the hip portion from the sirloin and the aitch portion from the round. The following measurements were recorded: hip bone weight, aitch bone weight, total pelvic weight, aitch bone length, aitch bone depth, aitch bone angle, pubic symphysis circumference, hook width, pin width, cranial pelvic depth, caudal pelvic depth, and pelvic length. Measurements were analyzed in SAS (version 9.2) using Proc GLM with a significance value of $P < 0.05$. A 2 × 5 (sex x weight range) factorial design was utilized. Hip bone weight, aitch bone weight, and total pelvic weight increased with increasing CW (total pelvic weight = 2.37, 2.59, 2.73, 3.01, and 2.86 kg, respectively; $P = 0.03$). Longer aitch bone length ($P = 0.04$) and pelvic length ($P = 0.03$) were observed in steers when compared with heifers (aitch bone length = 15.8 and 14.9 cm; pelvic length = 39.2 and 36.2 cm, respectively). Photographs were taken of both the hip and aitch bone pieces from various angles to further illustrate the variation in pelvic shape. From representative photography of 6 mm medial to lateral slices it appears the size of the ball of the aitch bone and shape (angle) of the aitch bone was influenced by the accuracy of how the carcass was split. As the cut progressed laterally from the true pelvic midline, the shape of the ball became distorted changing from circular to oblong in nature. Similarly, the angle of the aitch bone increased, becoming more planar. These data suggest that aitch bone shape is influenced by accuracy of carcass split and that gender differences are reflected in the pelvic bone characteristics.

Key Words: aitch bone, beef, pelvis

250P Protein oxidation of beef due to high oxygen packaging occurs at a gradient and cannot be controlled by feeding antioxidants. L. Senaratne-Lenagala* and C. Calkins, *University of Nebraska, Lincoln.*

The effects of high oxygen (80% O_2: 20% CO_2) modified atmosphere packaging (HiO_2-MAP) on myofibrillar protein oxidation at different depths in beef roasts and the effects of dietary antioxidants (AGRADO PLUS, Novus International Inc.; AG) as a control measure were studied. Crossbred (British × Continental) steers (n = 467) were fed corn-based finishing diets containing 0 (corn) or 30% wet distillers grains plus solubles (WDGS) supplemented with (150 ppm) or without AG (0 ppm) for the last 160 d. After 48 h, 40 USDA Choice beef shoulder clods (n = 10 per diet) were collected and aged 8 and 29 d at 0 ± 2°C. After aging, beef clod hearts (*m. triceps brachii*) were removed. Roasts were packaged in HiO_2-MAP and displayed under retail conditions for 6 d. After display, 3 2.54 cm-thick steaks, from outside to inside (labeled as outer-most, middle and inner-most steaks), were removed, vacuum-packaged and stored at −20°C. Myofibrillar proteins were collected both parallel and perpendicular to the muscle fibers from outside to inside of roasts. Protein oxidation was quantified by measuring carbonyls and free thiols (sulfhydryls). Data were analyzed as a 4 × 2 × 2 × 3 factorial design (4-diets, 2-aging periods, 2-muscle-fiber directions, and 3-layers). More carbonyls and fewer free thiols indicate more protein oxidation of samples. There were no treatment effects on carbonyl contents ($P > 0.05$). Free thiols were higher ($P = 0.05$) in roasts from cattle fed WDGS without AG diets than those fed other diets. For both aging periods, the outer-most layers - both parallel and perpendicular to the muscle fibers - had higher ($P < 0.0001$) carbonyl contents compared with subsequent layers. Carbonyls ($P < 0.0001$) increased and free thiols ($P = 0.0002$) decreased extensively in the outer-most layers of beef aged longer. Carbonyls increased to a greater extent in the outer-most layer perpendicular to the muscle fibers than parallel to the muscle fibers ($P = 0.0002$). Protein oxidation due to HiO_2-MAP occurs at a descending gradient in beef and cannot be controlled by feeding antioxidants.

Key Words: high oxygen packages, protein oxidation, antioxidants

251P Relationship between proteolysis and oxidation in *longissimus dorsi* pork loin chops. R. M. Punt*, R. M. Smith, J. K. Grubbs, E. Huff-Lonergan, and S. M. Lonergan, *Department of Animal Science, Iowa State University, Ames.*

The purpose of this study was to investigate further the relationship between proteolysis and protein oxidation in the *longissimus dorsi* (LD) from pigs demonstrating differences in residual feed intake (RFI). Previous work has shown that the LD from pigs selected for lower RFI have less postmortem (PM) desmin degradation. Decreased desmin degradation could be due to an increase in protein oxidation which can inhibit proteolysis through inactivation of calpain. LD samples from pigs selected for RFI were used; a subset of samples 2 and 7 d PM (20 greatest and 20 least RFI, irrespective of selection line) from

previous work (n = 169, 80 low RFI line and 89 control RFI line) were used. Sensory, composition, and immunoblotting for troponin T (TnT) degradation (2 d PM), intact desmin (2 and 7 d PM), and immunoblotting for protein modification by 4-hydroxynonenal (4HNE) (2 d PM) was performed. To calculate the amount of protein oxidation in the form of modification by 4HNE, the density of 8 prominent bands, present in all lanes, were compared with a reference sample within each blot, a ratio was calculated for analysis. Data were analyzed using the Mixed procedure in SAS with fixed effects of line, group, and MC4R genotype and random effects of sire, pen, and litter. The Proc Corr procedure was used to calculate the Pearson correlations for each trait measured. RFI was different between the high value and low value RFI groups (0.3245 and −0.1213 kg feed/d respectively)($P < 0.0001$). Desmin degradation, TnT degradation, and 4HNE modification were not different between RFI groups. Intact desmin at d 7 p.m. tended to be negatively correlated with RFI (−0.258, $P = 0.107$), however, TnT degradation was not correlated with RFI. Oxidation was correlated with intact desmin at d 7 p.m. (0.443, $P = 0.0042$), indicating a decrease in proteolytic activity may be due to oxidation. These data indicate the protein oxidation may influence proteolysis in postmortem muscle possibly by inactivating the calpain system. This work was supported by AFRI Grant 2010–04568.

Key Words: pork, desmin, oxidation, troponin T

252P Nutrient differences of beef from different genotypes. M. Semler*, C. Calkins, and G. Erickson, *University of Nebraska, Lincoln.*

This study was conducted to determine tenderness and nutrient composition differences of steers from different genotypes (Angus, Angus × Piedmontese, and Piedmontese). The genotypes had zero (0C), 1 (1C), or 2 (2C) copies of the myostatin gene with base pair deletions which cause muscle hypertrophy (n = 21, 22, and 16). All steers were fed the same diet individually for 182 d, and then finished for 50 d, for a total of 232 d on feed. At 3 d post mortem samples were taken from the carcasses. Samples for nutrient analysis (proximate, lipid, and mineral content) were constructed from 58 *longissimus dorsi* (LD) (0C = 20, 1C = 22, and 2C = 16) and 59 *semitendinosus* (ST) (0C = 21, 1C = 22, and 2C = 16). Steaks for nutrient analysis were cut to 1.3cm thickness trimmed to 3 mm of fat and frozen. Steaks for Warner-Bratzler shear force (WBS) determination were aged for 14 d and cooked fresh, never frozen. All steaks were cooked to an internal temperature of 71°C then wrapped in oxygen permeable film and placed in a cooler at 4°C for 24 h. Six cores were taken from each steak parallel with the muscle fiber direction. Steaks from ST of 0C cattle were higher ($P < 0.01$) for WBS values (3.6 vs. 3.1 kg) than 2C samples. The LD steaks from 2C samples had a higher ($P < 0.13$) WBS value (2.9 vs. 2.6 kg) than the 0C. When comparing samples from 2C to 0C fat content ($P < 0.01$) decreased (0.78 vs. 7.88%) and total calories decreased ($P < 0.01$; 117.6 vs. 178.7) while moisture ($P < 0.01$) and protein levels ($P < 0.01$) increased. The 2C samples had a lower percentage of monounsaturated fatty acids than 0C and 1C samples ($P < 0.01$). The 0C and 1C samples had a lower level of cholesterol ($P < 0.01$) and a lower percentage polyunsaturated fatty acids ($P < 0.01$) when compared with 2C samples. The increase in percentage of trans fatty acids in 2C was not significant ($P < 0.11$). Mineral analysis showed a decrease in iron ($P < 0.01$) and an increase in calcium ($P = 0.38$) for 2C compared with 0C and 1C. These results suggest that beef from cattle with 2 copies of the myostatin gene had less overall fat content and calories than those with 0 copies.

Key Words: myostatin, nutrient analysis, Piedmontese, beef

253P Impact of restricted feeding on the growth performance of growing-finishing pigs from two genetic lines. N. S. Grohmann*[1], M. Ellis[1], B. A. Peterson[2], and B. F. Wolter[2], *[1]University of Illinois, Urbana, [2]The Maschhoffs, Carlyle, IL.*

Modern lines of pigs are conventionally given ad libitum access to feed throughout the growing period and still maintain relatively high feed efficiency. However, there is limited data on the impact of restricting the amount of feed given to growing pigs on growth performance. This study was carried out from 38.4 ± 1.87 kg to 123.3 ± 3.68 kg BW as a RCBD with a 2 × 2 factorial arrangement of treatments: 1) sire line (Line A vs. B); 2) feeding level (ad libitum vs. restricted). Purebred barrows from 2 commercial sire lines (n = 80; 40/line and feeding level) were individually housed and fed. Pigs on the restricted level were fed at approximately 83% of the intake of pigs on the ad libitum level with feed being offered twice per day. Diets were formulated to meet the nutrient requirements of the restricted fed pigs and to meet or exceed the requirements proposed by NRC (1998). There was no difference ($P > 0.05$) between the sire lines for any of the growth and carcass measures. Pigs on the restricted compared with the ad libitum treatment had lower ADG (886 vs. 1014 g, respectively; SEM 16.1; $P < 0.001$) and ADFI (2.36 vs. 2.84 kg, respectively; SEM 0.041; $P < 0.001$). There was a sire line by feeding level interaction ($P < 0.05$) for feed efficiency. For Line A, there was no effect ($P > 0.05$) of feeding level on G:F (0.369 vs. 0.364, respectively; SEM 0.0048); however, for Line B, pigs on the restricted compared with the ad libitum treatment had improved G:F (0.383 vs. 0.350, respectively; $P < 0.05$). These results suggest that restrict feeding of individually penned growing-finishing pigs can improve feed efficiency but that this response may be genotype dependent.

Key Words: carcass, feeding level, growth, pigs

254P Time of feeding flaxseed or fish oil on the fatty acid content of trimmed pig bellies and sensory evaluation of bacon. H. R. Martínez-Ramírez*[1,2], L. M. Pivotto[1], I. B. Mandell[1], J. K. G. Kramer[2], and C. F. M. de Lange[1], *[1]Centre for Nutritional Modelling, Department of Animal and Poultry Science, Guelph, ON, Canada, [2]Agriculture and Agri-Food Canada, Guelph, ON, Canada.*

Pork products containing n-3 PUFA such as 18:3n-3 (ALA), 20:5n-3 (EPA), 22:5n-3 (DPA) and 22:6n-3 (DHA) may provide health benefits to consumers. However, feeding pigs with n-3 PUFA sources such as flaxseed (FS) or fish oil (FO) may compromise consumer acceptance of pork products. Groups of 8 pigs per treatment (4 barrows and 4 gilts, Landrace × Yorkshire × Duroc) were fed either FS or FO containing diets over 3 different time periods (G, F, or C for 25–65, 85–120, or 25–120 kg BW; respectively), yielding 6 treatments. A 7th treatment, a diet free of FS and FO served as control (CON). Trimmed bellies (Belly) were harvested at 120 kg BW and assessed for fatty acid (FA) content and processed into bacon to evaluate sensory characteristics. Within FS or FO treatments the cumulative n-3 PUFA intake was similar across the 3 treatments ($P > 0.10$; 7 and 2 kg of FS and FO, respectively). Growth performance and carcass characteristics were not influenced by dietary treatments ($P > 0.10$). In terms of FA content (mg/100 g fresh belly), ALA was independent of FS feeding regimen ($P > 0.10$; 1765, 2214, 1935 for FSG, FSF, and FSC; respectively), and higher ($P < 0.001$) than the other treatments (421, 659, 496, and 314 for FOG, FOF, FOC, and CON; respectively). Content of the sum of EPA, DPA and DHA was independent of FO feeding regimen ($P > 0.10$; 628, 715, and 636 for FOG, FOF, and FOC; respectively), higher ($P < 0.001$) than FS (117, 113 and 154, for FSG, FSF and FSC; respectively); and lowest for CON (69; $P < 0.05$). Bellies from pigs on FS

had a lower n-6:n-3 PUFA ratio than FO ($P < 0.05$; 2.4 vs. 4.5); both were lower than CON ($P < 0.001$; 13). Based on trained taste panel analysis of bacon, off-flavor ratings were higher for FOF and FOC than FSE and CON ($P < 0.05$; 2.35, 2.18, 0.53, and 0.32; respectively); whereas ratings were similar for FSF, FSC, and FOG ($P > 0.10$; 1.39, 0.71, and 1.45). These results indicate that enrichment of n-3 PUFA in belly appears independent of timing of when n-3 PUFA containing diets are fed during pig development, and that feeding FO in the pre-slaughter diet may reduce consumer acceptance of pork

Key Words: pig, n-3 PUFA, flaxseed, fish oil

255P Effects of maternal activity, offspring sex, and birth weight on muscle fiber characteristics in newborn piglets. A. Reyaz*, E. K. Harris, V. P. Singh, P. P. Borowicz, K. R. Maddock Carlin, J. D. Magolski, K. A. Vonnahme, and E. P. Berg, *Department of Animal Sciences, North Dakota State University, Fargo.*

Maternal physical activity from mid to late gestation increases umbilical blood flow in swine [Harris et al., 2010 J. Anim. Sci. 88 (E-Suppl. 3):27]. We hypothesized that increased umbilical blood flow would enhance muscle fiber development. The objective of the current study was to determine if maternal activity as well as sex of the offspring and birth weight could affect muscle characteristics. Semimembranosus muscles (SM) were collected within 12 h of birth from piglets born to Yorkshire gilts (n = 8) assigned to control (Con) or exercise (Ex) treatment. The lightest (L) and heaviest (H) male (M) and female (F) piglets from each litter were selected for necropsy where SM was histologically processed for fiber type determination by actomyosin ATPase activity. Five representative images per sample were taken at magnification of 200x. The fiber type count (Types I, IIA, and IIB), fiber type area, nuclear count, and nuclear size were determined using Image Pro Plus. Nuclei count per fiber area was calculated. Fiber type and fiber type ratio was not affected ($P > 0.1$) by treatment, sex of offspring, or piglet wt. Fiber count tended to be increased ($P = 0.06$) in LM vs. HM and LF, which did not differ. Fiber area was increased ($P = 0.01$) in L vs. H piglets. The number of nuclei tended to be increased ($P = 0.08$) in HF vs. LF and HM which did not differ. There was a sex by weight interaction ($P < 0.05$) for nuclear size where LF had increased ($P < 0.05$) nuclear size compared with LM, with HF and HM being intermediate. There was a sex by treatment interaction ($P = 0.03$) for nuclear count per fiber area with ConF being greater than ConM and ExF, which did not differ. We reject our initial hypothesis. The increased nuclei number per fiber area in female piglets from Con gilts may mark a potential for increased growth during post-natal life, leading to more efficient muscle development.

Key Words: muscle fiber type, neonate, pig

256P Determining the effect of tryptophan to large neutral amino acids (LNAA) ratio on growth performance of finishing pigs. S. Nitikanchana*[1], M. D. Tokach[1], S. S. Dritz[1], J. Usry[2], J. M. DeRouchey[1], R. D. Goodband[1], J. R. Bergstrom[1], and J. L. Nelssen[1], *[1]Kansas State University, Manhattan, [2]Ajinomoto Heartland LLC, Chicago, IL.*

Recent research indicates that the Trp:Lys requirement may be higher in finishing pig diets containing high levels of corn distillers dried grains with solubles (DDGS). Because LNAA are greatly increased in high DDGS diets, 96 pigs (PIC TR4 × 1050) were used in 2 14-d studies to determine the effect of standardized ileal digestible (SID) Trp:LNAA ratio on growth performance. Experimental diets were fed in early- (35 to 48 kg BW) and late-finishing (83 to 99 kg BW) with a common diet between periods. Dietary treatments in early finishing included: 1) a corn-soybean meal (SBM)-based diet without DDGS (3.8:1 Trp:LNAA), 2) a corn-SBM diet with 45% DDGS (3.0:1 Trp:LNAA), 3) a corn-SBM diet without DDGS but supplemented with similar amounts of LNAA as the diet containing 45% DDGS (3.0:1 Trp:LNAA), and 4) the LNAA-supplemented diet (treatment 3) with added L-tryptophan to increase the SID Trp:LNAA ratio (3.8:1). Diets in late finishing followed a similar format, but contained 30% DDGS and Trp:LNAA ratios of 4.1, 3.1, 3.1, and 4.1, respectively. Diets were formulated to 0.94 and 0.72% SID Lys in early and late finishing phase, respectively. Pens were allotted in a randomized complete block design with 4 pigs per pen (equal numbers of barrows and gilts) and 6 replications per treatment. From 35 to 48 kg, pigs fed 45% DDGS diet had poorer G:F ($P = 0.01$) compared with pigs fed other diets; however, no differences were found in other response criteria. From 83 to 99 kg, growth performance was not affected by dietary treatment. These results suggest that the high level of LNAA relative to Trp in diets containing 30% DDGS or greater may not be responsible for a higher tryptophan requirement in finishing pigs as suggested by previous research.

Table 1. Effect of tryptophan to LNAA ratio on the growth performance of early and late finishing pigs

	Corn-SBM	High DDGS	Corn-SBM + LNAA	Corn-SBM + LNAA+Trp	SE
SID Trp:Lys, %	16.5	16.5	16.5	21.0	
Early Finishing (35 to 48 kg)					
SID Trp:LNAA, %	3.8	3.0	3.0	3.8	
ADG, g	982	859	961	949	35.5
G:F	0.46[a]	0.41[b]	0.47[a]	0.45[a]	0.01
Late Finishing (83 to 99 kg)					
SID Trp:LNAA, %	4.1	3.1	3.1	4.1	
ADG, g	1066	1074	1128	1182	64.3
G:F	0.35	0.34	0.36	0.37	0.01

Key Words: large neutral amino acids, pig, tryptophan

257P Influence of dietary SID isoleucine:lysine ratio on the optimal tryptophan:lysine ratio for 6- to 11-kg pigs. S. Nitikanchana*[1], A. L. Chipman[2], M. D. Tokach[1], S. S. Dritz[1], and J. F. Patience[2], *[1]Kansas State University, Manhattan, [2]Iowa State University, Ames.*

A total of 475 nursery pigs (initially 6.1 kg, and 5 d postweaning) were used to determine the effects of standardized ileal digestible (SID) Ile:Lys ratio on the optimal SID Trp:Lys ratio for growth performance. Pens were allotted to 1 of 12 treatments in a randomized complete block design. Treatments were arranged as a 2 × 6 factorial with main effects of SID Ile:Lys ratio (52 and 60% of Lys) and 6 SID Trp:Lys ratios (14.7, 16.6, 18.5, 20.4, 22.3, and 24.0% of Lys). Each treatment had 8 replications with 4 or 5 pigs per pen, with equal numbers of barrows and gilts within block and across treatments. Treatment diets contained 58% corn, 25% soybean meal, and 10% dried whey without any blood products. L-isoleucine and L-tryptophan were used to adjust Ile:Lys and Trp:Lys ratios. All diets were formulated to 1.30% SID Lys with SID leucine and valine to lysine ratios of 111 and 70%, respectively. Overall, no SID Ile:Lys or SID Trp:Lys ratio interactions ($P > 0.27$) were observed. For the main effect of SID Ile:Lys ratio, no differences ($P > 0.21$) were observed in growth performance among pigs fed the 52 or 60% SID Ile:Lys ratio. Increasing the SID Trp:Lys ratio also had no effect ($P > 0.30$) on growth performance. In conclusion, dietary SID Ile:Lys ratio did not influence the response to increasing SID Trp:Lys ratios in 6.1- to 10.8-kg pigs. Our results also suggested that the SID Ile:Lys ratio is not greater than 52% for pigs fed diets based on corn, soybean meal, and whey.

Table 1.

	SID Trp:Lys, %						
	14.7	16.6	18.5	20.4	22.3	24.0	SEM
52% SID Ile:Lys							
ADG, g	319	350	334	328	341	347	20.19
G/F	0.78	0.77	0.78	0.77	0.78	0.79	0.014
60% SID Ile:Lys							
ADG, g	344	360	327	321	362	335	20.19
G/F	0.76	0.79	0.78	0.78	0.79	0.78	0.014

Key Words: growth, isoleucine, nursery pigs, tryptophan

258P Determining of the effect of lysine to calorie ratio on growth performance and blood urea nitrogen of growing barrows and gilts in hot season and cool season in a commercial environment. T. X. Zhou*, L. Yan, and I. H. Kim, *Department of Animal Resource & Science, Dankook University, Cheonan, Choongnam, South Korea.*

Two experiments were conducted to determine an optimum Lys:calorie ratio (g of total dietary Lys/Mcal of DE) for growing barrows and gilts in cool and hot seasons in a commercial environment. In experiment 1 (Exp.1), 96 barrows and 96 gilts were allocated in 1 of 4 treatment respectively. Each treatment had 12 replicate pens with 4 pigs per pen. The experiment was lasted for 34 d in the cool season (March 12 to April 15, the average temperature is about 24°C). Lysine:calorie ratio were attained by adjusting the amount of corn and soybean meal and supplementation of crystalline Lys. In Exp. 1, total Lys intake (barrows, 15.1, 16.1, 17.3 and 19.4 g/d; gilts, 14.7, 17.1, 16.9 and 16.0 g/d) and available Lys intake (barrows, 13.0, 13.9, 15.0 and 16.9 g/d; gilts, 12.7, 14.8, 14.7 and 16.0 g/d) were increased ($P < 0.05$) as dietary Lys:calorie ratio increased. The blood urea nitrogen (BUN) concentration on d 34 for barrows and BUN change for barrows and gilts were linearly increased ($P < 0.05$) in response to increasing dietary Lys:calorie ratio. For gilts, backfat was decreased and then increased

(Quadratical, $P < 0.05$) as increasing dietary Lys:calorie ratio. Exp. 2 had the similar design as Exp.1 with the exception that Exp. 2 was conducted in hot season (June 30th to September 11th, the average average temperature is about 30°C) for 42 d. Diet of Exp.2 was same as Exp.1. In Exp. 2, total Lys intake (barrows, 14.0, 17.0, 17.4 and 19.3 g/d; gilts, 14.3, 16.8, 17.6 and 19.6 g/d) and available Lys intake (barrows, 12.1, 14.7, 15.1and 16.8 g/d; gilts, 12.3, 14.6, 15.3 and 17.1 g/d) were increased ($P < 0.05$) as dietary Lys:calorie increased. On d 42, the BUN concentration was increased ($P < 0.05$) in response to the increasing dietary Lys:calorie ratio. In conclusion, Lys requirement was numerically different between cool and hot temperature and dietary Lys:calorie ratio of 2.7 can satisfy the requirement of 25 to 50 kg growing pigs.

Key Words: blood urea nitrogen, Lys:calorie ratio, growing pigs

259P Effects of dietary Thr:Lys ratio on growth performance and blood profiles in weaning pigs. J. Li*, H. Y. Beak, and I. H. Kim, *Department of Animal Resource & Science, Dankook University, Cheonan, Choongnam, South Korea.*

This experiment was conducted to evaluated the effect of different threonine:lysine ratios on growth performance and blood urea nitrogen (BUN) concentration in weaning pigs. A total of 90 weaning pigs [(Duroc × Yorkshire) × Landrace] with an initial average body weight of 6.6 ± 0.53 kg were allocated in 1 of 3 treatments. Each treatment had 6 replicate pens with 5 pigs per pen. The experiment lasted for 35 d and contained 3 phases, including phase 1 (d 0–7), phase 2 (d 8–21), phase 3 (d 22–35). Diets were formulated with different threonine:lysine ratios of 0.65, 0.67 and 0.69. Diets contained 1.43, 1.31 and 1.16% available lysine in 3 phases, respectively. Dietary available threonine concentration was 0.93, 0.96, 0.99% in phase 1, and 0.85, 0.88, 0.91% in phase2 and 0.75, 0.78, 0.80% in phase 3. Body weight was determined on d 0, d7, d21 and d35, and feed appearance was also recorded in each phase and then the ADF, ADFI and G:F ratio were calculated. On d 0, d 7, d21 and d 35, through all the experiment periods, ADG, ADFI and G:F ratio were not influenced ($P > 0.05$) by the dietary threonine:lysine ratio. However, on d 35, BUN concentration was increased ($P < 0.05$) as the dietary threonine:lysine ratio increased. In conclusion, dietary threonine:lysine ratio going above 0.65 does not improve the growth performance in weaning pigs, while can increase BUN concentration.

Key Words: blood urea nitrogen, threonine:lysine ratio, weaning pigs

260P Impact of tylosin phosphate on amino acid and energy digestibility of diets fed to growing pigs. C. M. Pilcher*[1], R. Arentson[2], and J. F. Patience[1], [1]*Iowa State University, Ames,* [2]*Elanco Animal Health, Greenfield, IN.*

Tylosin phosphate (TP) is a macrolide antibiotic used in swine diets to control diseases, such as ileitis and swine dysentery, and to improve growth performance. The objective of this study was to evaluate the impact of TP on AA and energy digestibility in growing pigs fed corn-soybean meal or corn-soybean meal-distillers dried grains with solubles (DDGS) based diets. Eighteen barrows (initial BW = 34.9 ± 1.00 kg) were surgically fitted with a T-cannula in the distal ileum and were allotted to an incomplete crossover design with 6 diets and 3 replicate periods. Treatments were arranged in a 2 × 2 factorial: TP (0 vs. 44 ppm) and DDGS (0 vs. 25%). Two N-free dietary treatments (0 vs. 44 ppm TP) were also included for determining basal ileal endogenous AA losses (IAA_{end}) and the effect of TP on basal IAA_{end}. Replicate periods included 4 d of adaptation to treatments and 2 sampling periods (SP1 and SP2). Fecal collection occurred on d 5 and 6 and ileal digesta collection on d 7 and 8 for SP1; whereas, SP2 included fecal collection on d 11 and 12 and ileal digesta collection on d 13 and 14. For N-free treatments, corn-soybean meal diets were fed d 1 through d 7 followed by a 5-d adaptation to N-free diet and ileal digesta collection on d 13 and 14. All samples from SP1 and SP2 were analyzed for DM and GE, and AA analysis was conducted on ileal digesta samples from SP2. There were no significant interactions ($P > 0.10$) between TP, DDGS or sampling period. Inclusion of DDGS reduced apparent ileal digestibility (65.3 vs. 71.9%; $P < 0.0001$) and apparent total tract digestibility (79.7 vs. 85.5%; $P < 0.0001$) of energy. There were no effects of TP on energy digestibility. There were no effects of TP on basal IAA_{end} ($P > 0.10$); therefore, standardized ileal digestibility (SID) AA values were calculated using means of the 2 N-free diets. The SID of Lys (79.6 vs. 84.1%; $P < 0.0001$) and all other indispensible AA, except Leu, was lower in the DDGS diets. Inclusion of TP did not influence SID of AA. In conclusion, under the conditions of this experiment, TP did not affect digestibility of AA or energy and the inclusion of DDGS did not affect the response to TP.

Key Words: tylosin phosphate, DDGS, swine

261P Withdrawn

262P The effects of Calibrin-Z adsorbent on weanling pigs with no mycotoxin challenge. B. R. Wu[1], Z. B. Yang[1], S. L. Johnston*[2], and F. Chi[2], [1]*Shandong Agricultural University, Tai'an, Shandong, China,* [2]*Amlan International, Chicago, IL.*

Calibrin-Z (CAZ), a processed calcium montmorillonite, binds mycotoxins in vitro and protects against mycotoxicosis in pigs. Improvement of FCR in weanling pigs had been seen when pigs were fed CAZ with no mycotoxin challenge; possibly linked to SBM consumption. The objective of these 2 studies is to determine if CAZ can protect against negative effects of feeding SBM to young pigs. In EXP I, 24 barrows weaned at d-21 were allotted to a 2x2 factorial and fed diets with soy protein isolate (SPI) or SBM with or without 0.5% CAZ for 21 d. Pigs were housed in individual crates with pig as the experimental unit (6 pigs/treatment). Blood, intestinal villi measurements, feces, and urine were collected and nutrient digestibility calculated. Feeding CAZ tended to increase feed intake ($P = 0.14$) and ADG ($P < 0.10$), mostly in the SPI diet ($P < 0.10$). Pigs fed diets with CAZ had numerically higher dry matter, organic matter, crude protein (CP) and energy digestibility. Pigs fed SPI showed higher CP digestibility than pigs fed SBM ($P < 0.05$). Serum proteins were not different but pigs fed SBM without CAZ had higher blood urea nitrogen (BUN; $P < 0.05$). Pigs fed SPI with CAZ diet had higher villi heights ($P < 0.05$) than pigs fed SBM diets. In EXP II, 120 pigs weaned at d-21 were fed a common diet for 7 d then allotted to 2 treatments (10 pigs/pen and 6 pens/treatment), pen was the experimental unit. Pigs were fed corn-SBM based diets with or without 0.2% CAZ for 35 d in 2 phases. Feed intake and gain were determined weekly and blood and fecal samples were collected at the end of each phase. Feeding CAZ numerically improved FCR, reduced scour score, and reduced fecal N. Pigs fed CAZ had lower serum globulin and BUN than pigs fed the diet without CAZ ($P < 0.01$). In summary, young pigs fed CAZ tended to have better performance due to a tendency for better nutrient digestibility, higher intestinal villi heights, and lower BUN, implying CAZ may decrease the negative effects of feeding SBM to weaned pigs.

Key Words: nutrient digestibility, intestinal villi height, soy antinutritional factor, adsorbent

263P Effect of poultry fat and acidulated poultry fat on nutrient digestibility and performance in nursery pigs. S. M. Mendoza* and E. van Heugten, *Department of Animal Science, North Carolina State University, Raleigh.*

This study was designed to evaluate the effect of fat source and level on nursery pig performance and apparent digestibility of fat and gross energy. Pigs (n = 252; BW was 7.0 ± 0.2 kg) were weaned at 21 d of age and fed a common diet for 7 d. Pigs were housed 4 pigs per pen using a total of 63 pens and assigned within weight blocks to one of 7 dietary treatments. Diets were corn-soybean meal based (3.65% SID lysine/Mcal ME) and included a negative control diet without added fat and basal diets with either 2.5, 5.0, or 7.5% added fat from one of 2 fat sources, consisting of poultry fat (PF; 1.9% FFA, peroxide values (AOM) at 0, 4, and 24 h were 0.1 mEq/kg) and acidulated poultry fat (APF; 37.8% FFA, peroxide values at 0, 4, and 24 h were 0.1, 0.1, and 0.4 mEq/kg). Diets were fed in meal form. Growth performance was measured for 28 d and digestibility of fat and energy were determined using TiO_2 as indigestible marker. Fat supplementation increased ($P < 0.001$) final BW (19.9 vs. 18.4 kg) and ADG (460 vs. 405 g/d), regardless of source or inclusion level. Fat increased ($P < 0.001$) ADFI when added at 2.5% and then decreased ADFI with each further increment (663, 753, 681, and 653 g/d for 0, 2.5, 5.0, and 7.5% fat, respectively; quadratic effect, $P = 0.002$). Feed efficiency was improved quadratically ($P = 0.007$) with fat supplementation showing the greatest gain:feed ($P < 0.001$) at 5.0 and 7.5% (615, 615, 688, and 693 g/kg for 0, 2.5, 5.0, and 7.5% fat, respectively). Apparent digestibility of fat (17.8, 50.2, 71.0, and 77.3% for 0, 2.5, 5.0, and 7.5% fat, respectively) increased linearly ($P < 0.001$) and apparent digestibility of GE (76.1, 76.4, 83.3, and 84.4% for 0, 2.5, 5.0, and 7.5% fat, respectively) increased quadratically ($P < 0.001$) with increasing levels of fat, regardless of fat source. In conclusion, nursery pig performance and digestibility of fat and GE were improved when fat was added to the diets. No differences were observed between fat sources indicating that acidulated poultry fat, containing high FFA, could be an economical alternative to low FFA containing poultry fat.

Key Words: pigs, poultry fat, acidulated, free fatty acids

264P Effects of xylanase in finishing pig diets varying in energy and fiber on growth performance, carcass characteristics, and nutrient digestibility. J. A. Barnes*, J. M. DeRouchey, M. D. Tokach, S. S. Dritz, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan.*

A total of 576 pigs (initially 48.1 kg BW) were used in a 75-d trial to evaluate effects of xylanase (Porzyme 93010; Dansico Animal Nutrition, St. Louis, MO) in finishing pig diets varying in energy and fiber on growth, carcass traits, and nutrient digestibility. Pens of pigs were balanced by initial BW and gender, then randomly allotted to 1 of 6 treatments in a 2 × 3 factorial (with or without xylanase and 3 energy levels) with 8 pigs/pen and 12 replications/treatment. The 6 treatments were corn-soybean meal-based diets with dried distillers grains with solubles (DDGS), wheat middlings (Middlings), and choice white grease (CWG) arranged to make low- (3.30 Mcal ME/kg; 30% DDGS, 12.5% Middlings, and no CWG), medium- (3.38 Mcal ME/kg; 15% DDGS, 6.25% Middlings, and 1.2% CWG), and high-energy diets (3.45 Mcal ME/kg; no DDGS or Middlings, and 2.4% CWG) with or without xylanase (0 or 4,000 units xylanase/kg). All ph 3 diets contained 0.5% chromic oxide. Fecals were collected on d 42 via rectal massage from at least 4 pigs/pen. No xylanase × energy interactions occurred for any growth criteria. Pigs fed diets with xylanase had poorer ADG ($P < 0.03$; 976 vs. 992 g/d) compared with those without. Increasing dietary energy increased (linear; $P < 0.001$) ADG (959, 985 and 1,009 g/d) and G:F (0.332, 0.343 and 0.350) with no affect on ADFI. For carcass traits, increasing dietary energy increased (linear; $P < 0.01$) yield, HCW, backfat depth, and reduced (linear; $P < 0.001$) fat free lean index and jowl fat iodine value. Apparent digestibility of ADF improved ($P < 0.002$; 67.9 vs. 63.1%) with xylanase; however, no differences were found for other nutrient digestibility criteria. Also, as dietary energy increased, apparent digestibility of DM, N, fat, GE, ADF, and NDF increased (linear; $P < 0.02$). In summary, feeding diets with increasing energy levels improved pig performance. Although ADF digestibility was increased with xylanase supplementation, growth, carcass traits, and other nutrient digestibility values were not improved.

Key Words: energy, growth, finishing pig, xylanase

265P Effects of dietary supplementation of herb on growth performance, nutrient digestibility, blood profiles and meat quality in finishing pigs. J. H. Cho*, J. H. Jung, and I. H. Kim, *Department of Animal Resource & Science, Dankook University, Cheonan, Choongnam, South Korea.*

This experiment was conducted to determine the effect of dietary supplementation of herb on growth performance, nutrient digestibility, blood profiled and meat quality in finishing pigs. A total of 144 finishing pigs (average BW = 50.09 kg) were allocated into 1 of 3 treatments with 12 replicate pen per treatment and 4 pigs per pen by a random block design. Dietary treatments were: 1) CON, basal diet; 2) A, basal diet +0.1% turmeric and houttuynia cordata; 3) B, basal diet + 0.1% Taraxaci herb and Pueraria lobata. The present experiment included 2 phases, phase 1 (wk 0–5) and phase 2 (wk 5–10). In each phase, BW and feed consumption were recorded to calculate ADG, ADFI and G:F ratio. Digestibility of DM, N, and energy were measured according to the methods described by AOAC (1995). Blood sample were collected from 2 pigs per pen which were healthy. On the final day of the experiment, 6 pigs per treatment were slaughtered to determine the meat quality. During wk 0–5 and overall the experiment, ADG was higher ($P < 0.05$) in A and B treatments compared with CON treatment. During wk 5–10, pigs in A treatment had a higher ($P < 0.05$) ADG than CON treatment. No difference was observed on ADFI and G:F ratio through all the experimental periods. Dietary treatments did not influence ($P > 0.05$) digestibilities of DM, N and energy on wk 5 and wk 10. Furthermore, red blood cell (RBC) and white blood cell (WBC) counts, Lymphocyte, and IgG concentrations were not affected ($P > 0.05$) by dietary treatments. Pigs fed A and B diets had a higher ($P < 0.05$) LMA than pigs fed CON diet. However, no difference ($P > 0.05$) was observed on CIE meat color, sensory evaluation, drip loss, cooking loss, pH and WHC. In conclusion, dietary supplementation of herb can improve growth performance and increase LMA of finishing pigs but not affect DM, N, and energy digestibilities and blood profiles.

Key Words: meat quality, herb extract, finishing pigs

266P Effect of two probiotics on the performance of weaned piglets. IJ Wellock*[1], P. Toplis[1], and A. Stewart[2], *[1]Primary Diets, Yorkshire, UK, [2]Harper Adams University College, Newport, UK.*

An experiment was conducted to evaluate the effect of 2 differing probiotics on 20 d post-weaning pig performance and determine if there was a synergistic effect on their combination. The probiotics tested were *Bacillus* spp. (*Bacillus subtillis/Bacillus licheniformis* at 0 and 400 g/t; 1.3×10^9 cfu/kg feed; supplied by Chr. Hansen, Hørsholm, Denmark) and live yeast (*Saccharomyces cerevisiae* at 0 v 1 kg/t; 1.25×10^{10} cfu/kg feed; supplied by AB Vista, Malborough, UK). A total of 180 mixed sex piglets (Large White/Landrace/Duroc × Pietrain) weaned at 26 d of age (initial BW = 9.1 ± 0.21 kg) were allocated to the 4 dietary treatments (9 pens per treatment, 5 pigs/pen) in a randomized complete block design. Pigs were fed according to 2 phases; diet 1 (1–7 d) and diet 2 (8–20 d). All diets contained 2500 mg/kg zinc and 1700 ppm copper and exceeded BSAS nutrient requirements. There was no significant effect of *Bacillus* spp. inclusion, or significant interaction between *Bacillus* spp. and live yeast on pig performance during any period of the trial. Inclusion of live yeast significantly improved average daily gain (ADG; 381 vs 411 g/d; $P = 0.015$) and feed conversion ratio (FCR; 1.30 vs 1.24; $P = 0.009$) over the 20 d period. This was mainly due to improved performance between d 8 and 20 (ADG = 519 vs 549; $P = 0.022$ and FCR = 1.21 vs 1.17; $P = 0.033$). Inclusion of live yeast did not affect feed intake. The use of a live yeast significantly improved growth and feed conversion, which may be due to an overall improvement in nutrient utilization by the pig although this mechanism should be further investigated. There was no further benefit on combining *Bacillus* spp. and *Saccharomyces cerevisiae*.

Key Words: piglet, probiotic, yeast

267P Effect of lipid source and oxidation level on DE, ME, and apparent total-tract digestibility (ATTD) of DM, GE, EE, N, and C in young pigs. P. Liu*[1], B. J. Kerr[2], T. E. Weber[2], C. Chen[1], L. J. Johnston[1,3], and G. C. Shurson[1], *[1]University of Minnesota, St. Paul, [2]USDA-ARS, Ames, IA, [3]West Central Research and Outreach Center, Morris, MN.*

To evaluate the effect of lipid source and oxidation level on DE, ME, and ATTD of DM, GE, EE, N, and C of young pigs, 108 barrows (~6.66 kg BW) were assigned to dietary treatments in a 4 × 3 factorial design. Main effects were lipid source [corn oil (CN), canola oil (CA), poultry fat (PF), and tallow (TL)] and oxidation level [original lipids (OL), slow oxidation (SO) of lipids heated for 72 h at 95°C, or rapid oxidation of lipids (RO) heated for 7 h at 185°C]. Pigs were provided ad libitum access to diets for 28-d, followed by an 8-d limited (4%

BW) feeding period. The SID Lys, Met, Thr, and Trp to ME ratios of lipid diets were constant. The SO increased ($P < 0.01$) peroxide value in all lipids. Both SO and RO increased ($P < 0.01$) thiobarbituric acid reactive substances in CN and CA and led to the production of 4-hydroxynonenal (HNE) in CN (194 and 594 mmol/kg, respectively), CA (105 and 221 mmol/kg, respectively) and TL (13 and 6 mmol/kg, respectively), while only SO resulted in production of HNE in PF (2 mmol/kg). Additional lipids to diets had increased ($P < 0.05$) ATTD of EE, and tended to improve ($P = 0.06$) ATTD of GE than the control diet. Feeding CN or CA increased ($P < 0.05$) ATTD of DM, GE, EE, N, and C compared with feeding TL, while feeding PF improved ($P < 0.05$) ATTD of GE and EE, and tended to increase ($P = 0.06$) ATTD of C compared with TL. Pigs fed CN had increased ($P = 0.05$) N retention rate than those fed TL. No oxidation level or interactions were found for DE and ME. Lipid source tended ($P = 0.08$) to affect DE but not ME content. DE values for CA (8846, 8682, and 8668 kcal/kg) and CN (8867, 8648, and 8725 kcal/kg) were about 450 kcal/kg higher than that of TL (8316, 8168, and 8296 kcal/kg), with PF being intermediate (8519, 8274, and 8511 kcal/kg) for OL, SO, and RO, respectively. Lipid source affected ATTD of DM, GE, EE, N, and C, N retention rate, and tended to influence DE value. Rapid and slow heating of lipids evaluated in this study increased lipid peroxidation products but did not affect nutrient digestibility and lipid DE and ME value.

Key Words: lipid source, oxidation level, energy, young pigs

268P Effect of alcohol-based energy source and animal-based specialty protein sources on nursery pig performance. W. Ying*[1], J. M. DeRouchey[1], M. D. Tokach[1], S. S. Dritz[1], R. D. Goodband[1], J. L. Nelssen[1], W. E. Schiefelbein[2], and R. L. Odgaard[2], *[1]Kansas State University, Manhattan, [2]XFE Products, Des Moines, IA.*

A total of 347 nursery pigs (PIC 1050, 5.0 kg BW) were used in a 44-d trial to determine the effect of an alcohol-based energy source (LE, XFE Liquid Energy, XFE Products, Des Moines, IA) and a poultry digest (AV-E, AV-E Digest;) on nursery pig growth. Pens of pigs were randomly allotted to 1 of 8 treatments with 9 pens/treatment. Treatments were in 3 phases (Table 1) and arranged as 2 × 3 factorial plus 2 controls with 2 protein source regimens (AV-E and spray-dried blood cells (SDBC) replacing animal plasma (SDAP) and PEP2+; dried porcine intestinal mucosa; TechMix, LLC, Stewart, MN; maintaining common SBM levels except in phase 3) and 3 energy sources (control, LE, and choice white grease; CWG). All diets were formulated to the same SID lys:ME ratio within phase. From d 0 to 9, feeding LE tended ($P < 0.08$) to improve ADG (134 vs. 116 g) compared with pigs fed diets without LE. No other differences in growth were observed. From d 9 to 23, pigs fed AV-E had greater ($P < 0.04$) ADG (340 vs. 312 g) than pigs fed PEP2+. Pigs fed CWG had greater ($P < 0.01$) G:F (0.70 vs. 0.66) than pigs fed LE. From d 23 to 44, ADG (541 vs. 508 g) and G:F (0.67 vs. 0.63) were improved ($P < 0.01$) by feeding CWG. Also, pigs fed CWG had better ($P < 0.01$) G:F (0.67 vs. 0.63) compared with pigs fed LE. Adding dietary AV-E did not affect growth in this phase. Overall (d 0 to 44), pigs fed CWG had increased ($P < 0.02$) ADG, G:F, and final BW over pigs not fed additional energy source and improved ($P < 0.01$) G:F compared with pigs fed LE. There was no difference in growth between protein sources. In conclusion, added CWG in nursery diets improved performance while LE did not. Also, AV-E was found to be an effective specialty protein source in phase 1 and 2 diets.

Table 1.

Trt	1	2	3	4	5	6	7	8	
d 0 to 9	Con	7.1%PEP2+ SDAP	7.1% PEP2+, 3.75% SDAP, 3%LE	7.1% PEP2+, 3.75% SDAP, CWG	7.1% PEP2+, 3.75% SDAP, 3% CWG	12.5% AV-E, 2.5% SDBC	12.5% AV-E, 2.5% SDBC, 3%LE	12.5% AV-E, 2.5% SDBC, 3% CWG	
d 9 to 23	Con	Con	3.8%PEP2+	3.85% PEP2+, 3%LE	3.85% PEP2+, 3%CWG	7.5%AV-E	7.5% AV-E, 3%LE	7.5% AV-E, 3%CWG	
d 23 to 44	Con	Con	Con	3%LE	3%CWG	2.5%AV-E	2.5% AV-E, 3%LE	2.5% AV-E, 3%CWG	SEM
d 0 to 44									
ADG[a], g	377	371	356	383	383	377	373	400	15.8
G:F[ab]	0.64	0.65	0.65	0.67	0.69	0.66	0.65	0.70	0.01

[a]CWG effect, Trt 3 and 6 vs. 5 and 8, $P < 0.05$; [b]CWG vs. LE, Trt 4 and 7 vs. 5 and 8, $P < 0.05$.

Key Words: energy, protein, pig

269P Effect of β-mannanase and β-glucanase in diets containing corn-soybean meal-dried distillers grains with solubles on nursery pig performance. M. Gandarillas*[1,3], S. Yu[1], Z. Rambo[1], D. Kelly[1], B. Richert[1], and J. Ferrel[2], *[1]Purdue University, West Lafayette, IN, [2]ChemGen Corp., Gaithersburg, MD, [3]Pontificia Universidad Católica de Chile, Santiago, Chile.*

One hundred ninety-two pigs (initial BW = 6.30 ± 0.026 kg; 20 d of age) were utilized to evaluate the effect of enzymes, β-mannanase or in combination with β-glucanase, in corn-soybean meal-corn distillers dried grains with solubles (DDGS) diets on pig growth and feed efficiency during the nursery period. Pigs were allocated in a randomized complete block design of mixed gender pens, stratified by litter and initial BW to 4 treatments, with 6 pens/treatment and 8 pigs/pen. Dietary treatments were negative control (NC; 1.0% added fat); T2, as NC plus β-mannanase (0.04 MU/kg); T3, as T2 plus β-glucanase (0.03 MU/kg), Positive Control (PC; 4.0% added choice white grease). Pigs were fed 2 dietary phases, phase 1 (d 0 to 14) with 12.5% DDGS, phase 2 (d 14 to 28) with 25% DDGS. Individual BW and pen feed disappearance were recorded weekly. Phase 1 ADG increased ($P < 0.05$) for T3 over NC and T2 treatments with PC being intermediate. Phase 1 ADFI was greater for T3 over all other treatments ($P < 0.05$). Phase 2 ADG tended to increase ($P < 0.10$) for T3 over PC. During phase 2, PC had reduced ADFI ($P < 0.05$) compared with all other treatments (688, 686, 720, 642 g/d, respectively). Pigs fed PC diet had increased G:F ($P < 0.05$) compared with NC and T3 while T2 was intermediate during phase 2 (0.593, 0.616, 0.597, 0.631, respectively). Overall (d 0 to 28), inclusion of β-glucanase with β-mannanase in T3 improved ADG ($P < 0.05$; 340, 346, 369, 345 g/d, respectively) and ADFI ($P < 0.05$; 549, 537, 585, 527 g/d, respectively) over all treatments. Overall G:F was significantly improved in PC and T2 versus NC ($P < 0.05$) with T3 being intermediate (0.619, 0.646, 0.631, 0.657, respectively). Final BW increased for T3 over NC with T2 and PC being intermediate (15.80, 16.02, 16.59, 15.98 kg, respectively). While additional work is needed to precisely define the response surface in relation to dietary composition and ratio to β-mannanase, the improvements in ADG by supplementing β-glucanase to β-mannanase are promising.

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

270P Effect of two ratios of supplemental β-mannanase to β-glucanase on grower pig growth performance. M. Gandarillas*[1,3], Z. Rambo[1], D. Kelly[1], J. Ferrel[2], and B. Richert[1], *[1]Purdue University, West Lafayette, IN, [2]ChemGen Corp., Gaithersburg, MD, [3]Pontificia Universidad Católica de Chile, Santiago, Chile.*

One hundred 36 crossbred pigs were used to determine the effect of 2 ratios of supplemental β 1,3 glucanase to β 1,4 mannanase (7:10 vs. 3:2) in corn-soybean meal diets with 25% corn dried distillers grains with solubles and supplemental phytase on pig growth performance during the grower (BW = 21 to 56 kg) period. Pigs were blocked by initial BW (20.8 ± 0.032 kg) and allocated in a randomized complete block design of mixed gender pens to 4 treatments. Treatments included: 1) negative control (NC) – no supplemental enzymes; 2) NC + 1000 phytase units/kg (PHY); 3) PHY + 0.08 MU/kg glucanase + 0.112 MU/kg mannanase (PHY+7:10); 4) PHY + 0.09 MU/kg glucanase + 0.058 MU/kg mannanase (PHY+3:2). All diets were formulated to meet (available P) or exceed (all other nutrients) NRC requirements of swine. There were 2 - 21 d phases with individual pig BW and pen feed disappearance recorded at d 0, 21, and 42 to calculate pen ADG, ADFI, and G:F. From d 0 to 21, pigs fed PHY and PHY+3:2 had 5.1% greater ADG ($P < 0.05$) and 6% greater G:F ($P < 0.05$) than NC. Additionally, PHY had greater ADG ($P < 0.05$) than PHY+7:10. There were no treatment differences in d 0–21 ADFI. No differences were observed in d 21–42 ADG among treatments. During d 21–42, PHY tended to have higher ADFI than PHY+7:10 ($P < 0.10$). Day 21–42 G:F was 6.6% greater with PHY+7:10 over NC and PHY ($P < 0.05$), with PHY+3:2 being intermediate. Overall, (d 0–42) PHY and PHY+3:2 tended to have greater ADG than NC ($P < 0.10$) with PHY+7:10 being intermediate (809, 842, 824, 841 g/d, respectively). Day 0–42 ADFI tended to be lower for PHY+7:10 compared with PHY ($P < 0.10$). Overall G:F was greater for PHY+7:10 over NC ($P < 0.05$) and PHY+3:2 tended to be greater than NC ($P < 0.10$), with PHY being intermediate (0.462, 0.473, 0.487, 0.480, respectively). Adding 1000 phytase units/kg plus 0.09 MU/kg glucanase and 0.058 MU/kg mannanase (3:2 ratio) improved ADG and final BW in grower pigs; however, feed efficiency was greater using an enzyme ratio of 7:10 in phytase supplemented diets.

Key Words: β-mannanase, β-glucanase, pig growth, phytase

271P Effects of XFE Liquid Energy and choice white grease on nursery pig performance. W. Ying*[1], J. M. DeRouchey[1], M. D. Tokach[1], S. S. Dritz[1], R. D. Goodband[1], J. L. Nelssen[1], W. E. Schiefelbein[2], and R. L. Odgaard[2], *[1]Kansas State University, Manhattan, [2]XFE Products, Des Moines, IA.*

Two experiments were conducted to evaluate the effects of XFE Liquid Energy (LE; XFE Products, Des Moines, IA) and choice white grease (CWG) on nursery pig growth. In Exp. 1, 150 nursery pigs (TR4 × 1050, 12.3 kg BW) were used in a 21-d trial. Pens were randomly allotted to 1 of 5 dietary treatments with 6 pens per treatment. Treatments included a corn-soybean meal-based control diet, the control diet with 2 or 4% CWG, and control diet with 2 or 4% LE. Overall (d 0 to 21), pigs fed LE had greater ($P < 0.04$) ADG and ADFI than control pigs. Pigs fed CWG had better (linear, $P < 0.05$) ADG and G:F than control pigs. Pigs fed CWG had better ($P < 0.02$) G:F compared with pigs fed LE. In Exp. 2, 228 nursery pigs (TR4 × 1050, 6.4 kg BW) were used in 30-d trial. Pens were randomly allotted to 1 of 6 dietary treatments with 7 pens per treatment. Pigs were fed in 2 phases, with phase 1 diets containing 4.5% fishmeal and 10% dried whey. The 6 dietary treatments were arranged in a 2 × 3 factorial with main effects CWG (0 or 4%) and LE (0, 2, or 4%). Overall (d 0 to 30), a CWG × LE interaction was observed for ADFI (quadratic, $P < 0.03$). Feeding LE in diets without CWG resulted in decreased ADFI; however, adding LE to diets containing CWG increased ADFI. Pigs fed CWG had lower ($P < 0.01$) ADFI and greater ($P < 0.01$) G:F than pigs fed no CWG. Feeding LE had no effects on ADG. Feeding CWG improved G:F in both experiments. The alcohol based LE product improved ADG without affecting G:F in Exp. 1. However, a similar response was not observed in Exp. 2.

Table 1. Effects of LE and CWG on growth performance

Exp.1		Control	2% CWG	4% CWG	2%LE	4%LE	SEM
d 0 to 21	ADG[abc], g	628	660	670	674	665	14
	ADFI[b], g	964	1000	958	1018	1012	20
	G:F[acd]	0.65	0.66	0.70	0.66	0.66	0.01

Exp.2		0%LE, 0% CWG	2%LE, 0% CWG	4%LE, 0% CWG	0%LE, 4% CWG	2%LE, 4% CWG	4%LE, 4% CWG	SEM
d 0 to 30	ADG, g	403	380	396	370	403	394	13
	ADFI[ef], g	631	591	622	550	588	565	17
	G:F[f]	0.64	0.64	0.64	0.67	0.69	0.70	0.01

[a]CWG vs. control, $P < 0.05$; [b]LE vs. control, $P < 0.05$; [c]CWG linear effect, $P < 0.05$; [d]CWG vs. LE, $P < 0.05$; [e]CWG×LE quadratic effect, $P < 0.05$; [f]CWG effect, $P < 0.01$.

Key Words: choice white grease, liquid energy, pig

272P Determination of digestible and metabolizable energy content of a corn-soybean co-extruded feedstuff for swine. K. Koch*, R. C. Bott, R. C. Thaler, and C. Hostetler, *South Dakota State University, Brookings.*

A metabolism trial was conducted to establish the digestible (DE) and metabolizable (ME) energy content of a corn-soybean co-extruded feedstuff for growing pigs. The test product is composed of 60% corn and 40% soybeans, which are then processed by extrusion. The experiment utilized 12 crossbred barrows, with an average initial body weight of 59.9 ± 1.4 kg, in a 2 period, crossover design. Barrows were housed individually in metabolism housing units. Dietary treatments included a basal diet (97.1% corn), and the test diet. The test diet was comprised of 70% basal diet and 30% corn-soybean co-extruded feedstuff on an as-fed basis. DE values for corn and soybeans, from the swine NRC, were used to calculate the basal and test diets to have 3630 kcal/kg and 3672 kcal/kg, respectively, on an as-fed basis. Barrows were blocked by treatment and split-rationed to include a morning and evening feeding. Daily rations were fed at 3 percent of individual body weight for a 9 d adjustment period, followed by a 4 d collection period. Throughout the collection period, total collections of feces and urine were performed during each morning feeding. Samples were pooled within barrow, frozen, and stored at 0°C until analysis of fecal and urinary energy was performed using isoperibol bomb calorimetry. Gross energy of dietary treatments was calculated using isoperibol bomb calorimetry. Digestible energy of treatments was determined by subtracting fecal energy from gross energy provided to barrows by each respective treatment. Metabolizable energy was determined by subtracting urinary energy from calculated digestible energy. On a dry-matter basis, the test diet contained 3908 kcal/kg DE and 3833 kcal/kg ME which was significantly greater than the

basal diet, which contained 3633 kcal/kg DE and 3567 kcal/kg ME ($P < 0.0001$). These data were used to establish the DE and ME of the corn-soybean co-extruded product to be 3882 kcal/kg and 3798 kcal/kg, respectively, on an as-fed basis. Therefore, this feedstuff is an appropriate energy substrate for inclusion in swine diets.

Key Words: ME, extruded, corn, soybean

Nonruminant Nutrition: Nursery and Growing-Finishing Nutrition and Management

273P The effects of high-sulfate water and dietary zeolite (clinoptilolite) on nursery pig performance. J. R. Flohr*, M. D. Tokach, J. L. Nelssen, S. S. Dritz, J. M. DeRouchey, R. D. Goodband, and N. W. Shelton, *Kansas State University, Manhattan.*

A total of 320 barrows (PIC 1050, 5.5 kg BW) were used in a 24-d study to determine the effects of high-sulfate water and dietary zeolite on growth performance and fecal consistency of nursery pigs. Eight treatments were arranged as a 2 × 4 factorial with 2 water treatments (control or water with 3,000 ppm sodium sulfate; $NaSO_4$), and 4 dietary zeolite levels (0, 0.25, 0.5, and 1.0%). Barrows were transported (623 km) from the sow farm and were weighed and allotted to pens. There were 8 replications/treatment with 5 barrows/pen. Water treatments remained the same from d 0 to 24, and all diets were fed in 2 phases, with the same zeolite inclusion rates in both phases. Phase 1 diets were fed in a pellet form (d 0 to 10), and phase 2 diets fed in meal form (d 10 to 24). Fecal samples were collected on d 5, 9, 16, and 23, visually scored for consistency (1 = firm, 5 = watery), and analyzed for DM. There were no water source × zeolite interactions for any response criteria. Overall (d 0 to 24), pigs drinking high-$NaSO_4$ water had decreased ($P < 0.01$) ADG, ADFI, and G:F compared with pigs drinking control water. Pigs drinking high-$NaSO_4$ water had increased ($P < 0.01$) fecal scores and lower ($P < 0.04$) DM on d 5, 9 and 16 compared with pigs drinking control water. Increasing dietary zeolite increased (linear, $P < 0.05$) ADG and ADFI, but had no effect on G:F. In conclusion, the 3,000 ppm $NaSO_4$ resulted in decreased pig growth performance that had indicators of less firm fecal consistency with lower DM and higher scores. Supplemental dietary zeolite increased ADG and ADFI but did not affect fecal score or DM.

Table 1. Effects of supplemental dietary zeolite and sodium sulfate water on nursery pig performance (d 0 to 24) and fecal consistency

	Zeolite				
Item	0%	0.5%	1%	2%	SEM
Control water					
ADG, g	277	284	283	291	12.53
G:F	0.77	0.76	0.78	0.79	0.02
d 9 fecal score	3.4	3.3	3.4	3.3	0.13
d 9 fecal DM, %	23.9	25.0	25.2	26.2	1.0
3,000 ppm $NaSO_4$					
ADG, g	229	259	268	265	12.53
G:F	.73	.76	.74	.73	.02
d 9 fecal score	4.0	4.0	4.4	4.0	.13
d 9 fecal DM, %	19.0	18.0	17.0	19.8	1.0

Key Words: nursery pig, sulfate, water, zeolite

274P Evaluation of feed budgeting, complete diet blending, and over and under feeding each phase on finishing pig growth performance and carcass characteristics. H. L. Frobose*[1], J. M. DeRouchey[1], D. Ryder[2], M. D. Tokach[1], S. S. Dritz[1], R. D. Goodband[1], and J. L. Nelssen[1], *[1]Kansas State University, Manhattan, [2]Feedlogic Corp., Willmar, MN.*

A total of 252 mixed sex pigs (PIC 327 × 1050; initial BW = 39.2 ± 0.4 kg) were used in a 103-d growth study to compare feed–budgeting strategies and complete diet blending for finishing pigs on growth performance, carcass characteristics and economics. Feed was delivered to all pens of pigs using a computerized feed delivery system (FEEDPro, Feedlogic Corp., Willmar, MN) which is capable of delivering and dispensing 2 separate diets concurrently. There were 9 pens/treatment and 7 pigs/pen in a randomized complete block design. There were 4 experimental treatments: 1) standard 4–phase (0.91, 0.77, 0.67, 0.61% SID, respectively) complete feed program (Standard); 2) Blending a high– and low–lysine complete diet to meet the estimated daily SID lysine requirement from d 0 to d 103 (Curve); 3) Treatment 1 diets with 20% greater feed budget per phase (Over), and 4) Treatment 1 diets with 20% lower feed budget per phase (Under). Diets were corn-soybean meal based with no added fat. The Standard diet was budgeted 53.1, 62.6, 71.7 and 79.4 kg for phases 1 to 4, respectively. Overall (d 0 to 103), there were no differences ($P \geq 0.12$) in ADG, ADFI or G:F or final BW. Pigs phase-fed a standard budget tended to have heavier ($P \leq 0.10$) carcasses (HCW) than pigs fed the curve and tended to have ($P \leq 0.10$) greater percentage yield than those fed the curve or the over-budget. However, there were no differences ($P \geq 0.14$) in percentage lean, fat depth, or loin depth. Because of heavier HCW, pigs fed the standard feed budget had greater ($P \leq 0.05$) revenue per pig and tended to have greater ($P \leq 0.10$) income over feed cost (IOFC) than pigs fed via the curve with pigs over- and under-budgeted being intermediate.

Table 1. Effects of feeding method using FEEDPRO on overall performance

Criteria	Standard	Curve	Over	Under	SEM
ADG, kg	0.94	0.91	0.92	0.93	0.011
ADFI, kg	2.51	2.48	2.46	2.50	0.03
G:F	0.37	0.37	0.37	0.37	0.004
HCW, kg	99.7^{y}	97.6^{x}	97.9^{xy}	98.5^{xy}	0.97
Yield, %	75.1^{y}	74.5^{x}	74.4^{x}	74.6^{xy}	0.24
Feed cost, $/pig	73.87	72.47	72.70	72.92	0.934
Revenue, $/pig	185.49^{b}	179.73^{a}	181.74^{ab}	183.75^{ab}	2.036
IOFC, $/pig	111.62^{y}	107.26^{x}	109.04^{xy}	110.83^{xy}	1.868

$^{a,b}P \leq 0.05$; $^{x,y}P \leq 0.10$.

Key Words: feed blending, feed budgeting, finishing pig, growth

275P Effects of increasing NDF from corn dried distillers grains with solubles (DDGS) or wheat middlings (Midds), individually or in combination, on growth performance, carcass characteristics, and fat quality in finishing pigs. M. D. Asmus*, J. M. DeRouchey, J. L. Nelssen, M. D. Tokach, S. S. Dritz, and R. D. Goodband, *Kansas State University, Manhattan.*

A total of 288 pigs (38.0 kg BW) were used in an 87-d study to determine the effects of increasing dietary NDF from middlings (14.1% CP, 42.1% NDF, and 9.6% CF) and DDGS (24.9% CP, 30.4% NDF, and 12.2% fat) on growth performance, carcass characteristics, and fat quality. Pigs were allotted to 1 of 6 dietary treatments (6 pens/treatment; 8 pigs/pen) with varying levels of DDGS and middlings added to corn-soybean meal-based diets to achieve NDF concentrations ranging from 9.2 to 18.8% (Table 1). Choice white grease (CWG) was added to maintain similar dietary SID lysine to ME within phase. The only DDGS × middlings interaction was a trend for carcass yield ($P = 0.09$). Adding middlings or DDGS to the diet reduced carcass yield, but the effect was not additive. Overall, adding middlings to

the diet decreased (linear, $P < 0.01$) ADG, G:F, final BW, and HCW, and increased (linear, $P < 0.001$) jowl fat iodine value (IV). Increasing DDGS did not influence growth or carcass traits except for an increase (linear, $P < 0.001$) in IV. Pigs fed increasing NDF had decreased (linear, $P < 0.05$) ADG, G:F, and HCW; however, these effects were driven by the pigs fed diets containing middlings and does not appear to be attributed solely to increased NDF levels. Increasing NDF also increased IV, but DDGS had a greater negative effect than middlings (due to the higher oil content of DDGS). In summary, increasing NDF has negative effects on growth, carcass yield, and IV, but the effects appear to be more closely related to individual ingredients.

Table 1.

	1	2	3	4	5	6			
NDF, %:	9.2	14	14	16.4	16.4	18.8			
Midds, %:	0	19	0	9.5	19	19			
DDGS, %:	0	0	30	30	15	30	SEM	Midds[a]	DDGS[b]
ADG, kg	1.07	1.02	1.11	1.08	1.03	1.01	0.01	<0.001	0.16
G:F	0.37	0.35	0.37	0.37	0.36	0.34	0.01	<0.001	0.72
Final BW, kg	130.1	126.3	133.2	132.7	126.6	125.8	1.30	<0.001	0.32
Carcass yield, %	73.8	72.2	71.9	71.5	72.2	72.4	0.69	0.37	0.17
HCW, kg	95.1	91.4	95.9	95.2	91.9	91.1	1.15	<0.001	0.82
Jowl IV	68.2	70.3	74.6	77.0	73.4	76.6	0.42	<0.001	<0.001

[a]Treatments 1 and 3 vs. 2 and 6; [b]Treatments 1 and 2 vs. 3 and 6.

Key Words: DDGS, NDF, wheat middlings, pig

276P Inclusion of corn germ and corn distillers dried grains with solubles in diets fed to growing-finishing pigs. J. W. Lee and H. H. Stein*, *University of Illinois, Urbana.*

A total of 280 pigs (initial BW: 42.5 ± 4.6 kg) were used to determine effects of adding corn germ (15.6% CP; 16.6% crude fat; 21.7% NDF) to diets fed to growing-finishing pigs. Pigs were randomly allotted to 1 of 8 dietary treatments in a 2 × 4 factorial design with 2 levels of corn distillers dried grains with solubles (DDGS; 0 or 30%) and 4 levels of corn germ (0, 10, 20, or 30%). The calculated ME was constant among all diets. Each diet was fed to 10 pens with either 3 or 4 pigs per pen. Pigs were fed phase 1, 2, and 3 diets for 28, 28, and 27 d, respectively. At the conclusion of the experiment, the pig that had a BW that was closest to the average BW of the pen was harvested. Results indicated that for the overall experimental period, there were no effects on pig growth performance of including corn germ in the diet regardless of the level of DDGS, but inclusion of 30% DDGS in the diet reduced ($P < 0.001$) ADG, ADFI, and final BW. There were no effects of corn germ on dressing percentage, carcass composition, muscle quality, or fat quality, but longissimus muscle (LM) marbling and firmness were reduced ($P < 0.05$) by inclusion of DDGS in the diet. The L* value of LM decreased (linear and quadratic, $P < 0.05$) as corn germ was included in diets containing no DDGS, but that was not the case in diets containing 30% DDGS (interaction, $P < 0.05$). Inclusion of corn germ in diets containing no DDGS increased belly length (quadratic, $P < 0.05$), but that was not the case in diets containing 30% DDGS. There was also a decrease in belly flop distance as corn germ was added to diets containing no DDGS (linear, $P < 0.001$), but no effects of corn germ were observed in diets containing 30% DDGS. However, inclusion of DDGS in the diet reduced ($P < 0.001$) the belly flop distance. In conclusion, addition of up to 30% corn germ in diets containing 0 or 30% DDGS did not negatively affect pig growth performance, carcass composition, or muscle quality, but belly firmness was reduced if no DDGS was included in the diet.

Key Words: corn germ, distillers dried grains with solubles, growth performance, pigs

277P Effects of dietary supplementation of emulsifier on growth performance, nutrient digestibility and blood characteristics in growing-finishing pigs. J. P. Wang*, S. M. Hong, and I. H. Kim, *Department of Animal Resource & Science, Dankook University, Cheonan, Choongnam, South Korea.*

The objective of this research was to evaluate the effect of exogenous emulsifier on growth performance, nutrient digestibility and blood characteristics in finishing pigs. A total of 160 crossbred barrows (initial body weight = 49.2 ± 1.3 kg) were randomly allotted to 1 of 4 treatments by their BW and litters (10 replicate pens per treatment, 4 pigs per pen). This experiment lasted for 10 weeks and there were 2 phases, growing phase (1 to 4 week) and finishing phase (5 to 10 wk). The experimental diets were based on corn and soybean meal. Treatments included: 1) PC (control diet with 5% added beef tallow and 3% soybean oil, ME = 3410 kcal/kg), 2) NC (control diet with 5% added tallow, ME = 3310 kcal/kg), 3) EA (NC diet with 0.07% lysophospholipids), and 4) EB (NC diet with 0.10% lysolecithins). Through all the experimental period, pigs in NC treatments had higher ($P < 0.05$) ADFI than PC treatment, and there was no difference in feed take among EA, EB, and PC treatments. The ADG was not affected by any dietary treatment. Those pigs fed PC and EA diets had better ($P < 0.05$) G:F than NC treatments from 1 to 4 weeks and the overall phase, but the EB treatments only improved ($P < 0.05$) the feed efficiency during 1 to 4 weeks. Apparent total tract nutrient digestibility (ATTD) of DM, nitrogen, fat and gross energy were increased by the EA and EB treatments as compared with the PC and NC diet ($P < 0.05$) at the end of 4 week. Gross energy and fat digestibility were improved in EA and EB treatments in 10 week. After the feeding period, meat samples from pigs which reached marketing BW were collected from the slaughter house. No numerical differences were observed in backfat thickness, meat color, pH value and water holding capacity (WHC) among 4 treatments. In conclusion, the addition of emulsifier can improve feed efficiency and nutrient digestibility in diet containing 5% tallow of finishing pigs.

Key Words: emulsifier, fat digestibility, growing-finishing pigs

278P Effect of altering the dietary n-6 to n-3 fatty acid ratio on the pro-inflammatory responses of newly weaned pigs when challenged with *E. coli* lipopolysaccharide. U. Damdinsuren[1], L. Eastwood*[1,2], and A. D. Beaulieu[1,2], [1]*Prairie Swine Centre Inc, Saskatoon, SK, Canada,* [2]*Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada.*

The objective of this experiment was to determine the effect of altering the n-6 (ω6) to n-3 (ω3) fatty acid (FA) ratio in diets of newly weaned pigs on their pro-inflammatory responses. Piglets (n = 120) were weaned on d 28 (±2) of lactation and were randomly assigned to 1 of 5 diets (5% crude fat); a tallow based control (low unsaturated fat) or plant based ω6:ω3 ratios of 10:1, 5:1, 1:1 (oil sources: canola, corn, flax) or a fish based (herring oil) 1:1 ratio. Individually housed piglets were fed diets for 6 d and then subjected to a 24 h *E. coli* lipopolysaccharide (LPS) challenge. Within each diet group pigs were randomized to a control group (saline) or to an LPS (15 ug/kg BW) injected group (n = 12/(challenge·diet). Rectal temperatures (temp) were recorded at

0, 1, 2, 3, 4, 5, 6, 12 and 24 h post injection and blood samples were collected at 0, 2, 6 and 12 h for cytokine analysis (IL-1β, IL-6, Il-8, TNFα). Area under the curve (AUC) was calculated for time course data and analyzed using PROC MIXED in SAS. Baseline temps and cytokines were similar between treatments ($P > 0.10$). The LPS elicited a pro-inflammatory response as evidenced by reduced ADG and ADFI, increased temp (39.4 vs 41.2°C) and increased plasma cytokine production ($P < 0.05$) for the 24 h challenge period. Rectal temp and IL-1β were unaffected by dietary treatment ($P > 0.10$). Pigs consuming the 5:1 ratio diet had a 2-fold increase in the AUC for IL-6 ($P < 0.01$) and tended to have increased IL-8 ($P < 0.1$) and TNFα ($P = 0.1$). Area under the curve for IL-6 was increased in the 5:1 LPS pigs (diet × challenge, $P < 0.01$) relative to saline and LPS pigs consuming the other diets. Pigs consuming a diet with an intermediate n-6:n-3 FA ratio of 5:1 had increased production of pro-inflammatory cytokines relative to pigs consuming the high and low n-6:n-3 ratio diets.

Key Words: piglet, n-3, cytokine, lipopolysaccharide

279P Effects of dietary distillers dried grains with solubles (DDGS) on growth performance and nutrient excretion of finishing pigs. H. J. Kim*, S. D. Carter, M. R. Bible, K. F. Coble, and T. M. Walraven, *Oklahoma State University, Stillwater.*

Eighty crossbred pigs were used to determine the effects of DDGS on growth performance and nutrient excretion during the finishing phase (39 to 124 kg). Pigs were housed in an environmentally controlled building with 4 identical rooms (20 pigs/room), each with a shallow pit, pull-plug system. Pigs were stratified by sex, BW, and ancestry, and randomly assigned to one of 4 rooms. Rooms were randomly allotted to one of 2 dietary treatments. The 2 dietary treatments included a fortified corn-soybean meal (control) diet and the control plus 25% DDGS (87% DM, 30.2% NDF, 28.6% CP, 0.80% P, and 0.50% S), which replaced corn, soybean meal, and dicalcium phosphate in the control diet. Digestible P of the control diet decreased by phase; however, digestible P in the DDGS diet was similar across all phases. Crystalline L-Lys, L-Trp and L-Thr were used to equalize CP content in the diets. At the end of each phase, feed intake was recorded and slurry samples were collected. There was no difference ($P > 0.10$) in growth performance between dietary treatments. Slurry pH (7.34 vs. 6.96) was decreased ($P = 0.02$), but slurry temperature and volume were not affected ($P > 0.10$) by DDGS. Intakes of DM (2,196 vs. 2,180 g/d) and N (63.06 vs.62.03 g/d) were not affected by DDGS. However, DDGS in the diet increased S intake (5.21 vs. 6.92 g/d; $P = 0.02$) by 33%. The daily excretion of DM (339 vs. 421 g/d; $P < 0.06$) and S (2.27 vs. 3.86 g/d; $P = 0.01$) was increased by 24% and 70%, respectively, for pigs fed DDGS. However, N and P excretion were not affected ($P > 0.10$) by DDGS in the diet. In addition, DDGS increased ($P < 0.06$) the cumulative excretion of S (218 vs. 370 g) and DM (339 vs. 421 kg) per pig for the entire finishing period, but the cumulative excretion of N and P was not affected ($P > 0.10$). In conclusion, 25% DDGS in the diet increases the intake and excretion of S, and increases DM excretion. Furthermore, N excretion can be limited for pigs fed DDGS with the use of crystalline amino acids. This work was partially funded by the National Pork Board.

Key Words: pigs, DDGS, nutrient excretion

280P The effects of pelleting, dried distillers drains with solubles source (DDGS), and supplementing sodium metabisulfite ($Na_2S_2O_5$) in nursery pig diets contaminated with deoxynivalenol. H. L. Frobose*[1], M. D. Tokach[1], E. L. Hansen[2], J. M. DeRouchey[1], S. S. Dritz[1], R. D. Goodband[1], and J. L. Nelssen[1], *[1]Kansas State University, Manhattan, [2]Hubbard Feeds, Mankato, MN.*

In a pilot study, adding sodium metabisulfite (SMB) during pelleting decreased (quadratic; $P \leq 0.001$) analyzed deoxynivalenol (DON) in naturally contaminated corn distillers dried grains with solubles (DDGS). Next, 360 barrows (PIC 1050, 11.2 ± 0.1 kg, 35 d of age) were used in a 21-d experiment examining the effects of pelleting the final diet, pelleting DDGS before final diet manufacturing, and including SMB in high-DON diets on nursery pig performance. Pigs were allotted to pens by BW, with pens assigned to 10 treatments in a randomized complete block design with 7 replicate pens and 5 pigs/pen. The 5 experimental diets were fed in meal or pellet form: 1) positive control (PC); 2) negative control (NC, 5.3 ppm DON); 3) NC with 0.5% SMB; 4) DDGS pelleted and reground (5.3 ppm DON); and 5) DDGS pelleted with 2.5% SMB and reground (final diet 0.5% SMB). All diets contained 20% DDGS (PC: 26.3% CP, 0.6 ppm DON; NC: 26.4% CP, 26.5 ppm DON). Final diets were lower in DON than predicted from ingredient analysis. No 2- or 3-way interactions were found. High-DON concentrations decreased ($P \leq 0.001$) ADFI and tended ($P \leq 0.06$) to decrease ADG. Pelleting PC and NC diets decreased ADFI ($P \leq 0.001$) and improved ($P \leq 0.02$) G:F. Within high-DON diets, pelleting tended to decrease ($P \leq 0.06$) ADFI and improved ($P \leq 0.001$) G:F; however, pelleting DDGS before manufacturing final diets did not influence growth performance. Supplementing SMB tended ($P \leq 0.08$) to decrease ADFI, but had no effect on ADG or G:F. Pelleting high-DON nursery pig diets can recover some reduction in ADFI by improving G:F. Pelleting DDGS and supplementing SMB did not improve performance in DON-contaminated diets in this study.

Table 1.

						$P \leq$			
	Treatment					PC vs. NC		High-DON diets[3]	
Item	PC	NC[2]	NC+ SMB[2]	Pelleted DDGS[2]	Pelleted DDGS+ SMB[2]	DON	M vs. P[1]	M vs. P	SMB
ADG, g (M)	617	587	573	591	576	0.06	0.30	0.44	0.54
ADG, g (P)	600	567	586	600	595				
ADFI, g (M)	963	891	852	901	879	0.001	0.001	0.06	0.08
ADFI, g (P)	891	858	836	882	856				
G:F (M)	0.64	0.66	0.67	0.66	0.66	0.45	0.02	0.001	0.12
G:F (P)	0.67	0.66	0.70	0.68	0.70				
DON, ppm[3] (M)	<0.5	3.2	3.3	3.0	2.8				
DON, ppm[3] (P)	0.5	3.2	0.7	1.9	0.5				

[1]Meal or pellet.
[2]Formulated to 5.3 ppm DON.
[3]Sum of analyzed DON and Acetyl-DON.
SEM was 15.1, 18.9, and 0.010 for ADG, ADFI, and G:F.

Key Words: deoxynivalenol, pelleting, nursery pig, sodium metabisulfite

281P Effect of graded levels of dietary spray-dried plasma on pregnancy rate of mated female mice under transport stress as a model for stressed sows. M. Song*[1], J. J. Lee[1], Y. Liu[1], J. A. Soares[1], T. M. Che[1], J. M. Campbell[2], J. Polo[2], S. W. Seo[3], and J. E. Pettigrew[1], *[1]University of Illinois, Urbana, [2]APC Inc., Ankeny, IA, [3]Chungnam National University, Daejeon, South Korea.*

Data from our 5 previous studies indicated that prolonged transport stress of mice immediately after mating resulted in a low pregnancy rate (average 11%), and that a high level (8%) of dietary spray-dried plasma (SDP) consistently and markedly increased the pregnancy rate (average 51%). This study was conducted to determine whether lower levels of SDP have a similar effect. Mated female mice (n = 202; 16.2 ± 1.16 g BW; C57BL/6 strain) were shipped from Bar Harbor, ME to Urbana, IL on the day the vaginal plug was found (gestation day (GD) 1), arriving at the laboratory in IL on GD 3. They were housed in individual cages and randomly assigned to dietary treatments (0, 1, 2, 4, and 8% SDP [CON, SDP1, SDP2, SDP4, and SDP8, respectively]). The diets were formulated to similar ME, CP, and AA levels without antibiotics, and fed for 2 wk. Pregnancy was determined on GD17 on the basis of BW and shape of abdomen, and was confirmed by inspection post-mortem. The pregnancy rate of mice fed the CON was low (7%). All SDP treatments increased ($P < 0.05$; Table) pregnancy rate markedly compared with the CON. Heavier mice were more likely to be pregnant ($P = 0.069$) than lighter mice, but all SDP treatments clearly improved ($P < 0.05$; Table) pregnancy rate regardless of initial BW and the interaction between initial BW and diet was not significant (Table). In conclusion, these data confirm that 8% SDP increases pregnancy rate of mated female mice under transport stress and show that even the lowest level of SDP (1% SDP) is effective.

Table 1. SDP effect on pregnancy rate of mated female mice under transport stress[1]

Item	CON	SDP1	SDP2	SDP4	SDP8	Initial BW[2]	Diet[2]	Interaction[2]
Overall, %	7 (3/42)	35 (14/40)	40 (16/40)	43 (17/40)	43 (17/40)	0.069	<0.05	0.38
Initial BW <16.5 g, %	4 (1/26)	27 (7/26)	33 (8/24)	32 (8/25)	38 (9/24)			
Initial BW ≥16.5 g, %	13 (2/16)	50 (7/14)	50 (8/16)	60 (9/15)	50 (6/16)			

[1]Data are number of pregnant/mated mice in the parentheses. Data were analyzed by chi-squared test.

[2]*P*-value for initial BW, diet, and interaction between initial BW and diet.

Key Words: mice, pregnancy rate, spray-dried plasma

282P Effects of graded levels of dietary spray-dried plasma on growth and fetal characteristics of pregnant mice as a model for sows. M. Song*[1], J. A. Soares[1], Y. Liu[1], J. J. Lee[1], T. M. Che[1], J. M. Campbell[2], J. Polo[2], S. W. Seo[3], and J. E. Pettigrew[1], *[1]University of Illinois, Urbana, [2]APC Inc., Ankeny, IA, [3]Chungnam National University, Daejeon, South Korea.*

Data from our previous study indicated that a high level (8%) of dietary spray-dried plasma (SDP) increased growth rate of pregnant mice (12%) and fetal wt (14%) compared with a control diet. This study was conducted to determine whether lower levels of SDP have similar effects. Mated female mice (n = 202; 16.2 ± 1.16 g BW; C57BL/6 strain) were shipped from Bar Harbor, ME to Urbana, IL on the day the vaginal plug was found (gestation day (GD) 1), arriving at the laboratory in IL on GD 3. They were housed in individual cages and randomly assigned to dietary treatments (0, 1, 2, 4, and 8% SDP [CON, SDP1, SDP2, SDP4, and SDP8, respectively]). The diets were formulated to similar ME, CP, and AA levels without antibiotics, and fed for 16 d. The pregnant mice (n = 67; 27.9 ± 2.06 g BW) were euthanized on GD 19 to measure growth performance of pregnant mice, number of fetuses, average fetal and placental wt, and organ wt (liver, spleen, lung, and kidneys). The SDP treatments increased ($P < 0.05$; Table) the ADG and G:F from GD 3 to 19, and number of fetuses per litter, average fetal wt, and wt of liver and spleen on GD 19, compared with the CON, but did not affect ADFI, placental wt, ratio between fetal and placental wt, and other organ wt. In conclusion, these data confirm that SDP increases growth of pregnant mice and their fetuses, and that the magnitude of response depends on the dose of SDP.

Table 1. SDP effects on pregnant mice

Item	CON	SDP1	SDP2	SDP4	SDP8	SEM	Diet[1]	L[1]	Q[1]
Pregnant mice, n	3	14	16	17	17				
ADG, g/d	0.54	0.65	0.67	0.75	0.77	0.03	<0.05	<0.05	<0.05
G:F	0.16	0.21	0.21	0.22	0.23	0.008	<0.05	<0.05	0.059
Fetuses/litter, n	5.6	5.6	6.1	7.0	7.0	0.42	<0.05	<0.05	0.38
Avg fetal wt, g	0.87	1.04	1.01	0.98	0.99	0.02	<0.05	0.28	0.069
Liver wt of BW, %	4.51	4.46	4.49	4.84	5.02	0.11	<0.05	<0.05	0.56
Spleen wt of BW, %	0.17	0.22	0.22	0.22	0.25	0.01	<0.05	<0.05	0.43

[1]*P*-value for diet and for linear (L) and quadratic (Q) effects of SDP.

Key Words: pregnant mice, fetal characteristics, spray-dried plasma

283P Feeding live *Saccharomyces cerevisiae* boulardii to sows increases immunoglobulin content in colostrum and milk. D. Guillou*[1], E. Chevaux[2], D. Rosener[2], Y. Le Treut[1], and J. Le Dividich[3], *[1]Lallemand SAS, Blagnac, France, [2]Lallemand Specialties Inc., Milwaukee, WI, [3]AV Kennedy, Breteil, France.*

The acquisition of passive immunity by the newborn piglet depends mainly on the amount of colostrum consumed and on its immunoglobulin G (IgG) content. To verify the hypothesis that sows fed the live yeast *Saccharomyces cerevisiae* boulardii CNCM I-1079 (SB) would produce more Ig in colostrum and milk, a trial including 66 Large White × Landrace sows was conducted in a commercial farm. They were housed and fed individually, and blocked by parity and body condition 3 weeks before expected parturition. A control group (C, n = 33) was fed the regular feeding program of the farm and an SB group (n = 33) was fed a supplement of 5×10^{10} cfu per day of SB from the start of the trial to weaning (21d). On each sow, colostrum was sampled randomly from most teats all along the udder just after birth of the first piglet, and 12 and 24h later. A sample of milk was collected after oxytocin injection on d 19 of lactation. Colostral Ig (A, G and M) and milk IgA were analyzed using a commercial ELISA kit. For colostrum data, the influence of treatment was evaluated in a mixed model of repeated measures considering the effect of sampling time, sow parity, treatment and their interactions. Milk IgA contents were compared with ANOVA including effects of parity and treatment. In the colostrum from control sows, IgG, IgA and IgM contents (mg/mL) were: 71.3, 10.5 and 5.7 respectively. In the milk, IgA from control sows was 4.9 mg/mL. Overall, feeding SB increased IgG and IgA content of colostrum by 21% ($P < 0.05$) and 18% ($P < 0.01$) respectively,

but didn't influence IgM concentration. Milk IgA tended to increase with SB (+18%, $P < 0.10$). These data support previous findings of an increase in piglet plasma IgG concentration following live yeast supplementation to the dam. To what extent the immune protection transferred to the piglet would be affected remains to be determined.

Key Words: sow, colostrum, immunoglobulins, probiotic

284P Dietary n-6 to n-3 fatty acid ratio affects body fat mobilization during lactation in high producing sows. L. Eastwood*[1,2], P. Leterme[3], and A. D. Beaulieu[1,2], *[1]Prairie Swine Centre Inc, Saskatoon, SK, Canada, [2]Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK, Canada, [3]Cargill R&D Centre Europe, Havenstraat, Vilvoorde, Belgium.*

Our objective was to determine if the dietary n-6 (ω6) to n-3 (ω3) fatty acid (FA) ratio affects fat mobilization in high producing sows and the ability to provide nutrients to their offspring. Sows (n = 100) farrowing ≥11 piglets and nursing ≥10 piglets were assigned to 1 of 5 diets (5% crude fat); a tallow based control (low unsaturated fat) or plant based ω6:ω3 ratios of 10:1, 5:1, 1:1 (oil sources: canola, corn, flax) or a fish based (herring oil) 5:1 ratio. Milk samples were collected on d 4 and 16 of lactation. Piglet ADG and sow ADFI was determined. Dry matter (DM), N and energy output of milk was estimated based on piglet ADG. Jugular catheters were inserted into 8 sows from each of the 10:1 and 1:1 groups on d 5 of lactation and sows were challenged with a single injection of epinephrine (epi) followed by serial blood collections for 2 h to determine diet effects on maximal body fat mobilization. Plasma leptin was determined on d 5 and 15. Feed intake was greatest for sows on the control (8.4 kg/d) and 5:1 plant (8.2 kg/d) diets and lowest for the 1:1 (7.4 kg/d) and fish (7.7 kg/d) diets (SEM 0.27; $P = 0.05$). Altering the ω6:ω3 FA ratio did not affect sow BW, piglet ADG or milk DM, N or total output ($P > 0.2$). Sows consuming the 1:1 ratio had greater backfat thickness ($P < 0.05$) and numerically higher plasma NEFA at baseline (d 5) when compared with the 10:1 sows (240 vs 93 u*M*, SEM 74.2; $P = 0.16$). When challenged with epi, sows fed the 10:1 diet had a lower net incremental area under the curve (niAUC) for glu ($P = 0.08$) and numerically higher niAUC NEFA ($P = 0.17$) and glycerol ($P = 0.15$) relative to the 1:1 sows. Despite being in a state of maximal body fat mobilization, sows fed a dietary n-6:n-3 FA ratio of 1:1 were able to provide the same level of nutrients to their offspring as the 10:1 fed sows.

Key Words: sow, n-3, fat mobilization, lactation

285P Predicting milk yield and composition in lactating sows. A. V. Hansen*[1,2], A. B. Strathe[1], E. Kebreab[1], and P. K. Theil[1], *[1]Department of Animal Science, University of California, Davis, [2]Department of Animal Science, Faculty of Science and Technology, Aarhus University, Tjele, Denmark.*

A quantitative description of the functional form of the sows′ lactation curve and changes in milk composition is a key component for estimation of nutrient requirements. The aims of the study were 1) to collate data and conduct a meta-analysis on milk yield (MY) and composition; and 2) to compare the new framework with the NRC for prediction of net milk energy output. The database for the MY analysis included information from 18 published studies and individual sow data from 3 studies. The database for analysis of milk composition included 27 published studies. The classical Wood curve ($MY(t) = a \times t^b \times \exp(-c \times t)$; t = day; Wood, 1967) was used to model time trends in MY (kg/d). The model incorporated random effects of experiment, sow nested within experiment, and fixed effects of litter size (LS), litter gain (LG) and method of MY determination. A second set of models were constructed to analyze milk composition data including day in milk (DIM) and dietary protein content (%). The models were used to calculate net energy (MJ/d) output in milk. Milk yield was affected by LS and LG ($P < 0.01$). Mean MY at peak lactation was 9.23 kg (SD = 0.14) and peak lactation was at d 18.7 (SD = 1.06). The average protein, lactose, and fat content were 5.22 (SD = 0.06), 5.41 (SD = 0.08), 7.32% (SD = 0.17), respectively. Four scenarios were constructed with LS at 9.5, 12, 8, and 9.5 and corresponding LG at 2.05, 2.6, 1.75, and 2.4 kg/d, respectively. The net energy requirement for milk production increased from d 5 to 20. When comparing the net energy output with calculations from NRC (1998), the NRC method underestimated the energy requirement for milk production by 0.3 to 10.3 MJ/d on d 5, 10, 15, 20, and 25, respectively. The difference between the NRC and the new framework is due to methodology because the new framework is founded upon the deuterium dilution technique whereas NRC is based on the weigh-suckle-weigh technique. The framework can be used to predict energy and protein requirements for lactation under different production targets and may be incorporated into a whole animal model for determination of energy and nutrient requirements for lactating sows, optimizing sow performance and longevity.

Key Words: sow, milk yield, milk composition, modeling

286P Rationalization of the dietary Ca levels by the use of phytase and 25OHD$_3$ in diets for lactating first-litter sows. M. A. Perez-Alvarado[1], D. Brana*[2], C. A. Mejia[2,1], J. Cervantes-Lopez[3], and J. A. Cuaron[2,1], *[1]Facultad de Estudios Superiores Cuatitlan, UNAM, Cuautitlan, Mexico, [2]Centro Nacional de Investigacion Disciplinaria en Fisiologia Animal, INIFAP, Queretaro, QRO, Mexico, [3]DSM Nutritional Products Mexico, El Salto, JAL, Mexico.*

Dietary Ca regularly exceeds the requirement, even if exogenous phytase is used. The rationale is to protect bone strength; similarly, excess vitamin D$_3$ is provided, but it is not recognized that a different form of the vitamin is necessary to achieve blood plasma levels of 25OHD$_3$ above 30 ng/mL. To test the hypothesis that the dietary addition of 25OHD$_3$ improves metabolization of Ca and P in presence of vitamin D$_3$, a total of 54 first-litter sows (of the same progeny) were used to measure productive performance and, from 24 with an average litter size of 11 pigs, the Ca, P, CP and energy balances during a 21d lactation period. Milk nutrients were accounted by change in pigs from birth to weaning. From parturition, 3 dietary Treatments were imposed: 1, a Control, similar to current commercial diets, formulated to 3.3 Mcal of ME/kg; Ca, 0.95% and digestible P (dP) of 0.35%. A diet corrected for the use of phytase (2): ME, 3.15 Mcal/kg; Ca, 0.55% and dP, 0.25%; these 2 diets included of vitamin D$_3$ at 1,800 IU/kg. Diet 3 was identical to the second, but 25OHD$_3$ was added (Rovimix Hy-D, 4 g.MT^{-1}, similar to 2,000 IU of Vitamin D$_3$). For the 3 diets, CP (15.5%) and SID Lys (0.87%) levels were similar, keeping equal the limiting amino acids ratio to Lys. Productive performance and nutrients balance were similar ($P > 0.14$), except for energy ($P < 0.03$), which was confounded by feed intake, but energy digestibility was better ($P < 0.01$) for the 2 phytase added diets (82.3 vs 87.7%), implying that the energy liberation by phytase (plus the reduction of Ca) was calculated correctly. It is notable that consumption (26%) and excretion of Ca (37%) and P (39%) were lower ($P < 0.001$) with the Ca and P reduced diets, but Ca retention was similar, for diets 1 to 3: −6.1, −6.4, −4.3 g/d ($P > 0.52$), as it was for P retention: −0.5, −1.0, −0.3 ($P > 0.82$). Hence, the use of phytase is an effective mean to reduce Ca and P wastage and it is suggested that 25OHD$_3$ is a good tool to protect Ca and P metabolization.

Key Words: vitamin D, phytase, calcium, phosphorus

287P Evaluation of the rates of mineral accretion per kilogram body weight gain and net energy intake for two genetic lines of barrows and gilts from 20 to 125 kilograms of body weight. A. P. Schinckel[1], D. C. Mahan*[2], T. G. Wiseman[2], and M. E. Einstein[1], *[1]Purdue University, West Lafayette, IN, [2]The Ohio State University, Columbus.*

Two genetic lines of barrows and gilts with different lean growth rates were used to determine BW and mineral growth from 23 to 125 kg BW. The experiment was a 2 × 2 x 5 factorial arrangement of treatments conducted in 2 replicates. Six pigs from each gender and genetic line were killed at approximately 25-kg intervals from 23 kg BW to 125 kg BW. At slaughter, tissues were collected and weighed. All components were ground and frozen until analyzed for mineral, protein and lipid content. The mineral mass data were fitted to alternative functions of BW. The allometric function, mineral mass = a BW^b, provided the best fit to the data. The linear form of the allometric equations was evaluated for the significance of the interactions of the regression coefficients with genetic line and sex. Daily accretion rates of each mineral component were predicted by using the derivatives of the functions. Daily NE intakes were estimated based on the daily protein and lipid accretion rates. Allometric growth coefficients for the mineral mass were different for each sex and genetic line for Ca ($P < 0.05$) and Mg ($P < 0.08$). Interactions of BW and genetic line were found for Se, Zn, S, and K ($P < 0.05$). Significant interactions ($P < 0.10$) of sex by BW were found for P and Fe. With the exception of Ca, the allometric coefficients for most of the minerals were either greater for gilts in comparison to barrows or for the high-lean gain pigs in comparison to the low-lean gain pigs. The high-lean gain pigs had greater rates of mineral accretion per predicted unit of energy intake. In several cases, the predicted ratio of mineral accretion to NE intake were from 10 to 20 percent greater for the high-lean than the low-lean gain pigs at 25 kg BW and increased to 20 to 50% from 100 to 125 kg BW. These results support the need for genetic population specific mineral nutrient recommendations.

Key Words: pig, mineral composition, growth, dietary requirements

288P Use of $25OHD_3$ favors opportune and sound bone maturation. D. Brana*[1], J. Gabriel-Landon[2], J. Cervantes-Lopez[3], and J. A. Cuaron[1,2], *[1]Centro Nacional de Investigacion Disciplinaria en Fisiologia Animal, INIFAP, Queretaro, QRO, Mexico, [2]Facultad de Estudios Superiores Cuatitlan, UNAM, Cuautitlan, Mexico, [3]DSM Nutritional Products Mexico, El Salto, JAL, Mexico.*

Structural unsoundness is a common cause of growth retardation and culling in swine herds, which commonly results in over-supplementation of Ca, P and vitamin D_3. However, Ca and P excesses maybe expensive and create physiological problems, while vitamin D_3 hardly results in $25OHD_3$ levels above 30 ng/mL of blood plasma. In this experiment 188, 56d-old crossbred growing gilts were randomized in a RCB (2 treatments, 2 blocks), to test the response to a high dietary concentration of vitamin D from $25OHD_3$. Gilts were individually housed from start and until d-168 of age, when moved to collective pens (6–8/pen) for reproductive management; these pens flooring was rough solid concrete, with a 7% slope, to challenge structural soundness. The feeding program was ad-libitum until an age of 168d, thereafter a maximum allowance of 8 Mcal of ME/d was offered. Five feeding phases were imposed, the first 4 in 28d intervals until 168d of age, with the last phase kept until 224d of age. Diets were calculated to contain 3.40, 3.35, 3.30, 3.25 and 3.20 Mcal of ME/kg; Ca, 0.61, 0.50, 0.49, 0.45 and 0.62%; digestible P, 0.25, 0.15, 0.13, 0.11 and 0.18%; Phytase was added at 750 FTU/kg to all diets. Treatments were established by the addition or not of $25OHD_3$ (Rovimix Hy-D, 4 $g.MT^{-1}$, similar to 2,000 IU of vitamin D_3/kg), on top of a minimum level of 1,530 IU from Vitamin D_3/kg. Growth performance was measured and a validated method of visual appraisal of 9 points for structural soundness was observed at 21d intervals. A minimum of 8 gilts per Treatment in 28d periods were used to collect bones for ashing and histological procedures. No differences in growth were detected until d-168 of age, but gilts fed additional $25OHD_3$ gained more weight and had improved feed efficiency ($P < 0.02$) after d-168 of age; these responses correlated well ($P < 0.001$) with the structural soundness score (final score was 5 for Control vs. > 5.75 for $25OHD_3$ fed gilts). Fibula ash, % dry bone weight, was greater ($P < 0.06$) in $25OHD_3$ fed gilts at d-168 of age, but fibula total ash was similar at the end. Osteoblast cell count was greater ($P < 0.02$, 21 vs. 44 cells/cm^2) in $25OHD_3$ fed gilts around d-120 of age, but was not different at any other time points. It is inferred that greater dosing of vitamin D from $25OHD_3$ improved bone development and contributed to better structural soundness in developing gilts.

Key Words: vitamin D, $25OHD_3$, calcium, phosphorus

289P Impact of highly oxidized corn dried distillers grains with solubles (DDGS) at increasing dietary vitamin E levels on nutrient digestibility and DE and ME content in diets for growing pigs. R. Song*[1], C. Chen[1], L. J. Johnston[2], B. J. Kerr[3], T. E. Weber[3], and G. C. Shurson[1], *[1]University of Minnesota, St. Paul, [2]West Central Research and Outreach Center, Morris, MN, [3]USDA-ARS-NLAE, Ames, IA.*

A study was conducted to evaluate the effects of feeding diets containing highly oxidized corn DDGS with 3 levels of vitamin E on DE and ME content, and apparent total tract digestibility (ATTD) of energy, N, C and S in diets for growing pigs. The DDGS source used in this study contained the highest thiobarbituric acid reactive substances (TBARS) value and peroxide value (5.2 ng/mg oil and 84.1 mEq/kg oil, respectively) among 30 other DDGS sources (mean values = 1.8 ng/mg oil and 11.5 mEq/kg oil, respectively). Growing barrows (n = 54) were assigned randomly to one of 6 dietary treatments in a 2 × 3 factorial design. Pigs were fed corn-soybean meal (CON) or diets containing 30% DDGS with 3 levels of vitamin E: none supplemented, NRC (11 IU/kg), or 10× NRC (110 IU/kg). Pigs were housed individually in metabolism cages for a 5-d adaptation period followed by a 3-d total collection of feces and urine. Feed, feces and urine were analyzed for GE, N, C and S to calculate the corresponding ATTD, daily balance, as well as DE and ME content of diets. The DE and ME content of DDGS diets were lower ($P < 0.05$) than CON (3,285 vs. 3,347 and 3,180 vs. 3,247 kcal/kg, as-fed basis, respectively). Dietary inclusion of 30% DDGS reduced dietary ATTD of GE (84.3 vs. 89.2%, $P < 0.001$), N (84.1 vs. 88.7%, $P < 0.001$) and C (85.0 vs. 90.0%, $P < 0.001$), but improved ATTD of S (86.8 vs. 84.6%, $P < 0.001$) compared with CON. Nitrogen absorbed tended to be lower ($P < 0.10$), and C absorbed and retained were lower ($P < 0.05$) in DDGS diets than CON. Intake, fecal and urinary excretion of S, and S absorbed and retained were higher ($P < 0.01$) in DDGS diets than CON. There was no significant interaction between dietary DDGS and vitamin E level, or effects of vitamin E on nutrient digestibility or dietary energy value in this study. In conclusion, feeding diets containing 30% highly

oxidized DDGS decreased the ATTD of GE, N and C, but improved the ATTD of S in diets. Supplementation of vitamin E in the diet did not counteract the negative effects of DDGS on nutrient digestibility.

Key Words: ATTD, DDGS, pig, vitamin E

290P Evaluating the impact of pre-weaning calcium and phosphorus supplementation on mineral status at weaning and growth of low and high birth-weight pigs. P. L. Y. C. Chang*[1], C. H. Stahl[1,2], and E. van Heugten[1], *[1]Department of Animal Science, North Carolina State University, Raleigh, [2]Laboratory of Developmental Nutrition, North Carolina State University, Raleigh.*

Neonatal Ca and P deficiencies affect growth performance and the activity of the tissue-specific stem cells responsible for lifetime muscle and bone growth. This study evaluated the effect of direct oral supplementation of Ca and P to nursing pigs on mineral status and growth. From commercial sows (n = 52), 2 light-weight pigs (LW, 1.52 ± 0.04 kg BW) and 2 heavy-weight piglets (HW, 2.14 ± 0.04 kg BW) were selected at d 3 of age. Within sow, 1 of the LW and 1 of the HW piglets were orally supplemented once daily with 2 mL of a $CaPO_4$ solution that provided 240 mg Ca and 182 mg P. The remaining LW and HW pig from each litter orally received 2 mL of a placebo. Pre-weaning mortality was 21% among the LW pigs and 1% among the HW pigs. Pigs were weaned at 22.5 d of age, weighed, and blood samples were collected for analysis of serum Ca, inorganic P, and PTH. Of the surviving pigs, only pigs weighing < 1.6 kg at d 3 of age for the LW group (mean BW = 1.36 ± 0.03) and pigs > 1.8 kg for the HW group (mean BW = 2.17 ± 0.02) were considered. Supplementation with $CaPO_4$ increased serum Ca at weaning in the LW pigs ($P < 0.02$; 103.6 vs. 100.0 mg/L), but tended to decrease serum Ca in HW pigs ($P = 0.07$; 101.2 vs. 103.4 mg/L). Serum inorganic P was higher ($P < 0.05$) in HW than LW pigs (66.4 vs. 63.4 mg/L), but was not affected by oral supplementation. Supplementation with $CaPO_4$ decreased ($P < 0.01$) serum PTH (16.6 vs. 21.6 pg/mL) in both weight groups. HW pigs gained BW faster than LW pigs during the pre-weaning phase ($P < 0.001$; 217 vs. 159 g/d). In the subsequent 44-d nursery phase, HW pigs grew faster than LW pigs ($P < 0.001$; 508 vs. 420 g/d). Pre-weaning supplementation of $CaPO_4$ decreased nursery ADG in LW pigs (395 vs. 444 g/d), but had no effect on the growth of HW pigs (interaction, $P = 0.09$). In conclusion, nursing pigs can absorb more Ca than is supplied to them through the sow's milk. This excess absorption did not benefit growth rate during either the pre-weaning or nursery phase. Additionally, $CaPO_4$ supplementation reduced ADG of LW pigs during the nursery phase.

Key Words: nursing pigs, pre-weaning nutrition, calcium, phosphorus

291P Dietary calcium in excess of requirement is absorbed and utilized by neonatal pigs. Y. Li, B. S. Seabolt, and C. H. Stahl*, *North Carolina State University, Raleigh.*

The importance of avoiding dietary Ca deficiencies to maintain bone integrity is well known. Additionally, the endocrine regulation of Ca homeostasis has been very well characterized in both growing and mature animals. Less is understood about Ca regulation during the early neonatal period. This study utilized 21 neonatal pigs (24–36 h old, 1.72 ± 0.15kg BW) to examine the impact of dietary Ca deficiency (30% below requirement), Ca adequacy (0.9% DM basis), Ca excess (40% above requirement) over a 15 d liquid feeding trial. All pigs received equal amounts of formula each day at a rate to allow them to match the growth of sow-reared pigs (n = 15). The growth rate, sera indicators of Ca status, bone ash weight, bone ash percentage, and urinary Ca concentrations of pigs fed the Ca adequate diet were not different from sow-reared pigs. Dietary Ca deficiency resulted in reduced ($P < 0.05$) growth rate and therefore feed efficiency, bone ash weight, bone ash percentage, and tended to increase circulating PTH. Dietary Ca excess did not alter growth performance when compared with the Ca adequate group. Excess dietary Ca did result in reduced ($P < 0.05$) circulating PTH, increased ($P < 0.05$) bone ash weight, bone ash percentage, and urinary Ca excretion. In addition to these changes in indicators of Ca status, there was also greater in vivo proliferation of bone marrow derived MSC in pigs fed excess dietary Ca. The in vitro differentiation capabilities of MSC isolated from pigs fed the excess Ca diet were significantly altered compared with those of MSC isolated from the Ca adequate pigs. Our data indicate that dietary Ca at levels greater than what is viewed as required can be absorbed and utilized by the neonatal pig. Excess Ca absorption resulted in an altered endocrine profile and affected the activity of MSC. Further research is needed to determine the true Ca requirements of neonatal pigs.

Key Words: neonatal, calcium, MSC

292P An oral dose of vitamin D at birth increased serum 25-OH D at weaning but failed to alter bone mineral density in pigs. L. A. Rortvedt*[2], P. M. Cline[1], C. Ryer[1], B. Frederick[1], K. J. Retallick[2], D. K. Schneider[2], and T. D. Crenshaw[2], *[1]Christensen Farms, Sleepy Eye, MN, [2]University of Wisconsin, Madison.*

Increased mortality attributed to a vitamin D induced hypocalcemia in pigs has prompted research of new procedures to supplement vitamin D. The current objective was to assess efficacy of a single oral megadose of vitamin D_3 at birth on serum 25-OH D_3 and bone ash at weaning. Within litters (n = 51), half of the pigs were either not dosed (Ctl, n = 296) or were given a single 1 mL dose of 40,000 IU vitamin D_3, (+D, n = 301). Gestation and lactation diets were formulated at 1,750 IU D_3/kg. Pig diets were formulated at 1,750 IU D_3/kg for 5 d before weaning and at 2,750 IU D_3/kg for a 35 d nursery trial. Blood and bone tissues were collected at weaning from 24 pigs (12/treatment). Serum 25-OH D_3 concentrations were approximately 3× lower ($P > 0.001$) in Ctl vs +D pigs (9.5 vs 29.8 ± 2.3 ng/mL, avg ± SEM). Despite increased serum 25-OH D_3 concentrations in +D pigs, no differences ($P > 0.30$) were detected between Ctl vs +D pigs in bone mineral content (BMC, g data not shown) or bone mineral density (BMD, g/cm^2) determined from DXA scans of excised femurs (0.356 vs 0.361 ± 0.009 g/cm^2) and spinal columns (0.294 vs 0.289 ± 0.008 g/cm^2). Likewise, no differences ($P > 0.30$) were detected between Ctl vs +D pigs in the percent ash (ash/dry, fat-free bone) of the tenth ribs (48.8 vs 49.8 ± 0.69%). Survival of all pigs from birth to weaning averaged 93.5% with no differences in mortality detected between Ctl vs +D pigs (7.1 vs 6.0%). Differences in mortality over the 35 d nursery trial were not detected between Ctl vs +D pigs (2.7% vs 1.9%). Pig ADG tended ($P < 0.10$) to be greater in Ctl vs +D groups (0.41 vs 0.38 ± 0.01 kg/d), but no differences were detected ($P > 0.30$) in ADFI or F/G ratio. In conclusion, +D treatments at birth increased serum 25-OH D_3 in pigs at weaning, but failed to improve bone mineralization. Although Ctl pigs had low (<10 ng/mL) serum 25-OH D_3 at weaning, no evidence of a deficiency was observed.

Key Words: hypocalcemia, mortality, neonatal pigs

Odor and Nutrient Management

293P The effect of probiotic (*Bacillus* product) on growth performance and fecal consistency of growing-finishing pigs. S. Nitikanchana*, M. D. Tokach, S. S. Dritz, J. M. DeRouchey, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan.*

A total of 1,099 pigs (PIC 1050 × 337; initially 34 kg) were used in a 104-d study to determine the influence of a *Bacillus* product and diet type on growth performance, carcass traits, fecal consistency, and pen cleaning time in growing pigs raised under commercial conditions. Pens were allotted in a completely randomized design with 26 to 27 pigs per pen and 7 replications per treatment. Treatments were arranged as a 3 × 2 factorial with main effects of *Bacillus* product (0, 1x, or 10x) and diet type (corn-soybean meal or a by-product diet with 30% dried distillers grains with solubles in all phases and 20% bakery until 54 kg). The dose of *Bacillus* in the diet was approximately 200 million and 2 billion cfu/g for the 1x and 10x levels, respectively. Overall (d 0 to 104), no differences were found in growth performance or carcass composition for pigs fed the *Bacillus* product; however, pigs fed the 1x level of *Bacillus* tended (quadratic, $P = 0.10$) to have the lowest ADG (998, 976, and 985 g for 0, 1x, and 10x *Bacillus* level, respectively). Manure texture score tended to increase (linear, $P = 0.07$) as *Bacillus* dose increased, indicating that pigs fed the *Bacillus* product had firmer stools. Wash time was numerically reduced (linear, $P = 0.16$) as *Bacillus* level increased in the diet (10.8, 10.6, and 9.9 min for 0, 1x, and 10x *Bacillus* level, respectively). For diet formulation, pigs fed the diet containing by-products had increased ($P = 0.01$) ADFI compared with pigs fed the corn-soybean meal diet (2629 vs. 2537 g, respectively). With no difference in ADG, feed efficiency was poorer ($P < 0.01$) for pigs fed byproduct diets (0.38 vs. 0.39). Pens that contained pigs fed byproduct diets required more ($P < 0.01$) time to wash (11.6 vs. 9.3 min), which appeared to be the result of looser manure texture ($P = 0.09$) and increased ($P = 0.08$) manure buildup. The *Bacillus* product tested did not improve growth performance, but altered fecal consistency and barn wash time.

Key Words: *Bacillus*, by-products, fecal consistency, pigs wash time

294P Evaluation of a commercial ozone treatment system to improve swine slurry. P. M. Walker[1], A. R. Omer*[1], M. S. Brewer[2], K. R. Cadwallader[2], and T. R. Kelley[3], *[1]Illinois State University, Normal, [2]University of Illinois, Urbana, [3]Eastern Carolina University, Greenville.*

Reducing volatile organic compounds (VOC) and odor emissions, of swine slurry help producers to meet existing and future environmental regulations. The objective of this study was to evaluate one technology designed to reduce odor emissions. The facility utilized was an environmentally controlled grow-finish building constructed over a manure pit capable of holding 408,297 L (107,730 gal) of slurry. During treatment the pit contained 170,126 L (44,888 gal) of slurry. The system injected air that was previously exposed to UV light at a rate of 0.18 cmm (6.25cfm) into slurry pumped at 379 lpm (100 gpm). This was equivalent to exposing the entire pit contents once every 7.5 h over a 96 h treatment period. Prior to treatment, slurry was analyzed to contain 4.61%solids, 6.8 pH, 482.5 ± 3.54 mg:l settable solids (SS), 2,175 ± 139 mg:l total suspended solids (TSS), 220.2 ± 3.8 ppm NH_3, less than minimum detection limits of dissolved oxygen (DO), 59,275 ± 3,866 mg:l chemical oxygen demand (COD), 0.49 ± 0.01%N and 1.55 ± 1.15%P with a 0.3:1 N:P ratio. Following 72 h solids concentration was lowered ($P < 0.05$) to 1.45%; SS were reduced ($P < 0.05$) 96.4%; TSS were reduced ($P < 0.05$) 77.9%; NH_3, DO and COD were not significantly different; N was lowered ($P < 0.05$) 42.9% to 0.28%; and, P was lowered ($P < 0.05$) to below detection limits. No significant changes between 72 h and 96 h in any of the characteristics measured were observed. Four air sample bags were collected before treatment and following 48 h, 72 h, and 96 h of treatment with subsequent analyses by a trained human odor panel (n = 8). The recognition threshold (lowest dilution concentration that odor could be recognized) before treatment was 1,382 ± 74 and was significantly lower after 48 h (205 ± 69). Odor intensity was significantly higher before treatment than after 48 h comparing mean intensities of 3.14 ± 0.26 and 2.29 ± 0.39, respectively. No changes ($P < 0.05$) in odor intensity or threshold were detected between 48 h and subsequent observations at 72 h and 96 h. Under production scale conditions the commercial ozone treatment system evaluated can reduce odor and can reduce the concentration of selected VOCs of swine slurry.

Key Words: odor, N:P ratio, swine slurry

295P Effects of sericite supplementation on nutrient digestibility, blood profiles, and noxious gas emission in growing pigs. H. Y. Beak*, X. Y. Guo, and I. H. Kim, *Department of Animal Resource & Science, Dankook University, Cheonan, Choongnam, South Korea.*

This study was conducted to assess the effects of sericite on nutrient digestibility, blood profiles, and noxious gas emission in growing pigs. Six [(Duroc × Yorkshire) × Landrace] pigs were used in a 3 × 3 Latin square design. Dietary treatments included 1) CON (basal diet), 2) T1 (CON + 0.5% sericite), 3) T2 (CON + 1.0% sericite). Each experimental period lasted 7 d. Pigs were fed diets containing Cr_2O_3 (0.2%) and after 5 d adaptation period to the diet, fecal samples were collected on d 6 and 7 of each period. All pigs were bled on d 0 and d 7 of each period. The GLM procedure of SAS (1998) was used to determine the treatment and time effects. No time effect or interaction between treatment and time were observed. Throughout the entire experimental period, the dry matter (76.5, 79.5 vs 82.2%) and nitrogen (78.8, 82.7 vs 84.3%) digestibility was improved ($P < 0.05$) in the T1 and T2 treatments compared with CON treatment. There was no difference in energy digestibility among the 3 treatments. The concentration of Fe (146, 146 vs 96 μg/dLin blood was decreased ($P < 0.05$) by T2 treatment at the end of the experiment, and the TIBC was not affected by any treatments during the experiment period. No differences were observed in fecal NH_3, H_2S, and total mercaptans during the whole experiment. In conclusion, diets supplemented with 0.5 or 1% sericite may prove effective in improving nutrient digestibility and Fe concentration can be decreased by 1% sericite in growing pigs.

Key Words: sericite, noxious gas emission, growing pigs

296P Effects of dietary fermented wheat by *Bacillus subtilis* on growth performance, nutrient digestibility, microbial shedding and fecal noxious gas emission in growing pigs. X. Y. Guo*, S. M. Hong, and I. H. Kim, *Department of Animal Resource & Science, Dankook University, Cheonan, Choongnam, South Korea.*

This research was conducted to evaluate the effect of fermented wheat (FW) by *Bacillus subtilis* on growth performance, nutrient digestibility, microbial shedding, and fecal noxious gas in growing pigs. A total of 120 pigs with initial BW of 28.8 ± 1.81 kg [(Landrace × Yorkshire) × Duroc] were randomly allotted into 1 of 5 dietary treatments with 6 replicate pens per treatment and 4 pigs per pen. Every

pen was equipped with semi-automatic feeder and nipple drinker. The pigs were housed in an environmental controlled, slatted-floor facility in 30 adjacent pens and were allowed ad libitum access to feed and water. The temperature and humidity of animal house were maintained at 24°C and 60%, respectively. This experiment lasted for 6 weeks. Pigs were fed a common corn-soybean meal basal diet for a 3 d adjustment period and then fed experimental diets. The experimental diets were formulated based on corn-soybean meal with FW at different levels of 0% (FW0), 5% (FW5), 10% (FW10), 15% (FW15), 20% (FW20). All experimental diets contained a total of 20% of wheat (nature wheat plus FW). Pigs fed FW10 and FW20 diets had higher ADG than pigs fed FW0 and FW5 diets ($P < 0.05$), however, no difference was observed in ADFI and G:F ratio among all dietary treatments ($P > 0.05$). Apparent total tract digestibility (ATTD) was unaffected by dietary treatments ($P > 0.05$). The microbial shedding was not affected by dietary FW. There was no difference in fecal noxious gas concentration (H_2S, total mercaptan, acetic acid and NH_3) among all treatments. In conclusion, ADG can be improved by FW10 and FW20 treatments. The fermented wheat can be used as an efficient feedstuff in growing pig diets.

Key Words: *Bacillus subtilis*, growth performance, growing pigs

297P Effect of probiotics on performance, noxious gas emissions and blood profiles in sows and litter performance. J. H. Jung*, T. X. Zhou, and I. H. Kim, *Department of Animal Resource & Science, Dankook University, Cheonan, Choongnam, South Korea.*

This study was conducted to evaluate the effect of dietary supplementation of probiotics on performance, fecal moisture, rectal temperature, noxious gas emissions, and blood profile in sows and litter performance. The experiment started 14 d before parturition to weaing d. Eighteen sows (Landrace × Yorkshire), with an average BW of 240.3 kg and average parity of 2, were used in a 35 d feeding trial, sows were randomly assigned to 1 of 3 treatments. Dietary treatments were basal diet (CON); 2) CON + 0.1% probiotics (PB1); 3) CON + 0.2% probiotics (PB2). The basal diet was based on corn and soybean meal. The probiotics used in this experiment contain 1.2×10^7 cfu/g *Bacillus subtilis*, and 1.15×10^6 cfu/g *Lactobacillus acidophilus*. After farrowing, daily feed allowance increased gradually, and sows had ad libitum access to feed and water by wk 2. Results showed that sows fed the PB2 diet had a greater birth weight of piglets than those fed the CON and PB1 diets (1.52 vs. 1.26 vs. 1.26 kg, SE = 0.1, $P < 0.05$), whereas the survival rate (98.7 vs. 96.0 vs. 98.6%, SE = 1.7), and weaning weight of piglet (6.86 vs. 6.60 vs. 6.29 kg, SE = 0.3) were unaffected by supplementation of probiotics to sow diet. No difference among dietary treatments was observed on the body weight (33 vs. 26.6 vs. 31.6 kg, SE = 7.6), and backfat thickness loss (6.2 vs. 5.4 vs. 6 mm, SE = 0.8) in sows after farrowing. The fecal moisture, rectum temperature, and noxious gas emissions in lactating sows were unaffected by probiotics administration. There was no difference among dietary treatments on blood profile of lactating sows and sucking piglets. Diarrhea score (0.20 vs. 0.21 vs. 0.15, SE = 0.07) in sucking piglets was also unaffected by dietary treatments. In conclusion, results of the current study indicated that supplemented probiotics in sow diet had little effect on the performance of sows and piglets. However, the birth weight of piglets could be improved by probiotics administration in sow diet.

Key Words: blood profile, noxious gas emissions, probiotics, sow

298P Evaluation of a dynamic pig growth model for prediction of manure output. A. B. Strathe*[1], A. Danfær[2], H. Jørgensen[2], and E. Kebreab[1], *[1]Department of Animal Science, University of California, Davis, [2]Department of Animal Science, Faculty of Science and Technology, Aarhus University, Tjele, Denmark.*

Accurate and precise estimation of the amount and composition of manure is essential in decision support for a sustainable manure management program. The objective of this study was to evaluate a dynamic pig growth model (Davis Swine Model) for predicting manure volume and nitrogen content. The database used for evaluation of the model was constructed from 110 digestibility trials using growing-finishing pig diets that had a wide range of nutrient chemical composition. For example, the crude protein (CP) and dietary fiber contents of the diets ranged from 87 to 420 and from 48 to 425 g/kg DM, respectively, providing a robust test of the model. The main inputs to the model were diet nutrient composition, feed intake, water to feed ratio and initial body weight. Root mean square prediction error (RMSPE) was used in evaluation of the model for its predictive power. Davis Swine Model traces the fate of ingested nutrients and water through digestion and intermediary metabolism into body protein, fat, water and ash. Nutrient and water excretion is quantified using the principle of mass conservation. The average daily observed and predicted manure production was 3.79 and 3.99 kg/d with a RMSPE of 0.49 kg/d. Prediction of manure output, resulting from feeding high fiber diets was challenging due to varying degree of water binding by the fibrous feedstuffs. There was a good agreement between observed and predicted mean fecal nitrogen output (9.9 and 9.8 g/d, respectively). Similarly, the overall observed and predicted mean urine nitrogen output was 21.7 and 21.3 g/d, respectively, suggesting minor mean bias. The RMSPE was 1.9 and 4.1 g/d for fecal and urinary nitrogen, respectively. Decomposing the prediction error of fecal nitrogen excretion into estimating CP content and digestibility suggested that the majority of the error were related to estimation of the CP content. Evaluation of the Davis Swine Model shows that the model predicts manure volume and nitrogen content well and will be used as an input to another process based model (DNDC) to estimate air emissions from swine operations.

Key Words: nutrient management, swine, modeling

Physiology

299P Ultrasound and phenotypic measures of the reproductive tract of prepubertal gilts selected for increased uterine capacity. C. A. Lents*, R. A. Cushman, and B. A. Freking, *USDA, ARS, US Meat Animal Research Center, Clay Center, NE.*

Direct selection for uterine capacity (UC) increases litter size without altering ovulation rate. A method to estimate UC in developing gilts would be beneficial for commercial selection strategies. We tested the hypothesis that selection for UC alters phenotypic characteristics of the reproductive tract of prepubertal gilts and that these changes could be estimated in live animals using transrectal ultrasound (TRU). Gilts from a line selected for UC or from a randomly selected control line (CO) were submitted for TRU at 130, 150, or 170 d of age and killed 24 h later (n = 10 gilts/line per age). Diameter of the uterine horn was measured (2 to 4 measurements per animal) at TRU. At sacrifice, measurements of each ovary (height, width, length, weight and number of visible follicles >1 mm) and uterine horn (weight, length, diameter, and endometrial diameter) were taken. There was no line × age interaction for any of the traits. All ovarian traits increased ($P < 0.03$) with age. Weight and length of the uterine horn was not different at 130 or 150 d, but was increased ($P < 0.01$) at 170 d of age. Diameter of the uterine horn tended ($P = 0.06$) to be increased at 170 d compared with 130 or 150 d, but age did not affect ($P = 0.38$) endometrial diameter. Ovarian weight and width were increased ($P < 0.01$) and ovarian length and height tended ($P = 0.07$) to be greater for UC than CO gilts, but the number of visible follicles did not differ. The UC gilts had increased ($P < 0.02$) weight of uterine horns, which tended ($P = 0.09$) to be longer than in the CO gilts. Diameters of the uterine horn and the endometrium were greater ($P < 0.01$) for UC gilts than for CO gilts. Uterine horn diameter measured with TRU was not affected by age or line, and was not correlated with any of the traits. Selection for increased UC results in larger ovaries and uterine horns, but TRU is not sensitive enough for estimating these traits in gilts of the age studied.

Key Words: gilt, development, uterus, ultrasound

300P Effect of melengestrol acetate and growth promotants on oocyte yield, quality, fertilization rate, and developmental competence of in vitro embryo production in beef heifers. N. A. Miller*[1], D. M. Greiger[1], K. E. Fike[1], A. Castro[2], and D. Dean[2], *[1]Kansas State University, Manhattan, [2]Sexing Technologies Inc., Navasota, TX.*

Oocyte quality affects success of in vitro embryo production and is influenced by factors such as age, follicle size, and reproductive and nutritional status of donor females. Beef feedlot heifers have potential to serve as viable donors of oocytes post-slaughter for in vitro embryo production; however, it is unknown if traditional feedlot heifer management practices of feeding melengestrol acetate (MGA) and using steroid-based growth promotants affect oocyte numbers and quality. The objective was to determine if feedlot heifers fed MGA and implanted with growth promotants could serve as viable donors for in vitro embryo production. Oocytes recovered, oocyte loss, fertilization rate, total embryos and stages of early embryo development were measured through d 7 post in vitro fertilization (IVF). Beef feedlot heifers were fed either MGA (0.05 mg/hd/d) and implanted with growth promotants (Revalor IH, 80 mg of trenbolone acetate, 8 mg of estradiol; Intervet, Inc., Millsboro, DE; MGA-Implant; n = 88) within the 120 d period before slaughter or served as untreated controls (not fed MGA nor implanted with growth promotants within 120 d of slaughter; Control; n = 84). Ovaries were obtained from heifers post-harvest and grouped (14 to 18 ovaries per group) by time of slaughter within treatment for oocyte collection. Aspirated oocytes were put into maturation media within 6 h post-slaughter and fertilized 24 h later. Treatment and time interacted ($P = 0.06$) to affect number of oocytes aspirated and zygotes produced per ovary. A similar percentage of zygotes cleaved by d 2 post-IVF (MGA-Implant: 46.8, Control: 47.9; $P > 0.05$). A similar percentage of embryos per ovary resulted for both treatments (MGA-Implant: 0.34; Control: 0.39; $P > 0.05$). In conclusion, beef feedlot heifers fed MGA and implanted with growth promotants appear to be a viable source of oocytes for in vitro embryo production.

Key Words: in vitro fertilization, MGA, oocyte, feedlot heifers

301P Effect of birth weight on age at puberty in gilts. M. J. Estienne*, *Virginia Tech, Blacksburg.*

Concomitant with the increased average litter size in commercial sows during the past 20 years has been an increase in the proportion of low birth weight pigs, likely due to intrauterine growth retardation (IUGR) caused by insufficient uterine capacity. Consequences of IUGR on postnatal performance in swine include greater rates of pre-weaning mortality and poorer postnatal growth rates. At harvest, low birth weight pigs have less muscle, are fatter, and have poorer meat quality. Reproductive effects of IUGR have been less studied but at birth, runt pigs (mean weight = 0.7 kg) had more primordial follicles, but fewer primary and secondary follicles than normal weight littermates (mean weight = 1.5 kg), indicating that IUGR delayed follicular development (Da Silva-Buttkus et al., 2003). The objective of this study was to examine age at puberty in gilts farrowed in litters with various average birth weights. Age at puberty, defined as the first standing estrus in the presence of a mature boar, was determined for 2 to 7 gilts from each of 33 litters that had a range of average pig birth weight of 1.13 to 1.98 kg. Age at puberty was negatively correlated ($r = –0.43$; $P < 0.01$) with average pig birth weight. For all litters, average pig birth weight was 1.5 kg. Age at puberty for gilts from litters (n = 20) with average pig birth weights above 1.5 kg tended to be less ($P = 0.09$) compared with age at puberty for gilts from litters (n = 13) with average pig birth weights ≤1.5 kg (186.7 ± 5 kg versus 198.3 ± 5). These results provide preliminary evidence that age at puberty is affected by birth weight in gilts.

Key Words: gilt, puberty, birth weight

302P Effect of selection for residual feed intake on sow performance I: lactation efficiency and reproductive performance. B. M. Adamic*[1], A. Rakhshandeh[1], J. M. Young[1], D. M. Thekkoot[1], T. E. Weber[2], J. C. M. Dekkers[1], and N. K. Gabler[1], *[1]Iowa State University, Ames, [2]USDA-ARS, Ames, IA.*

Residual feed intake (RFI), a measure of feed efficiency, is defined as the observed feed intake (FI) minus the expected FI based on estimated growth and maintenance requirements of each animal. The present study was conducted to evaluate the effect of genetic selection for low (LRFI) versus high RFI (HRFI) on sow lactation efficiency and reproductive performance. A total of 20 s-parity sows (body weight 179 ± 5.4 kg) from LRFI (n = 10) and HRFI (n = 10) lines were randomly selected from the 7th generation of the Iowa State University RFI herd and used in the current study. All sows were in the same body

condition and stage of lactation at the beginning of the study. Relative to HRFI, LRFI sows had lower ($P < 0.05$) average daily feed intake (5.6 vs. 4.0 kg/d, SE 0.21), and tended ($P < 0.09$) to have lower back fat depth at weaning (17.6 vs. 14.0 mm, SE 1.43) and gain to feed ratio (−0.08 vs. −0.21, SE 0.041). Overall, LRFI sows had more severe negative energy balance during lactation compared with their HRFI counterparts (−17 vs. −30 MJ/d, SE 5.0, respectively, $P < 0.05$). No differences were observed in sow average daily gain during the lactation period between the lines (HRFI vs. LRFI) (−0.4 vs. −0.7 kg, SE 0.15), sow body weight at weaning (187 vs. 175 kg, SE 5.7), estimated milk yield (7.5 vs. 6.9 kg/d, SE 0.35), sow litter size at birth (11.3 vs. 11.0, SE 0.81) and weaning (11.3 vs. 11.0, SE 0.39), piglet birth weight (1.3 vs. 1.4 kg, SE 0.42) and performance of the piglets at weaning ($P > 0.10$). These data provide no evidence that selection for LRFI has a detrimental effect on lactation efficiency and reproductive performance of sows at the second parity, but numbers of sows evaluated are small. However, the effect of lower energy balance in LRFI sows on their reproductive performance, such as weaning-to-estrus interval deserves further investigation. AFRI grant #2010–40568.

Key Words: residual feed intake, sow, lactation efficiency, reproductive performance

303P The relationship between feed efficiency and pancreatic lipase, α-amylase, and trypsin activity in beef steers. B. J. Awda*[1], Y. R. Montanholi[1], S. P. Miller[1], and K. C. Swanson[2], *[1]University of Guelph, Guelph, ON, Canada, [2]North Dakota State University, Fargo.*

The objective of this study was to examine pancreatic lipase, α-amylase, and trypsin activities in beef steers with differing feed efficiency as measured using residual feed intake (RFI). In this study, 24 crossbred steers predominantly of Angus and Simmental breeds were selected after a 140-d feeding trial from a total of 112 head for extremes (high (Hi; n = 12; 1.05 ± 1.11; mean ± SE) or low (Lo; n = 12; −1.10 ± 1.11; mean ± SE)) in RFI. The average age of the steers at the start of the test period was 275 ± 25 d (mean ± SD) and initial and final body weights were 338 ± 44 and 519 ± 51 kg, respectively. Steers were fed a high moisture corn-based diet. Body weights and ultrasound measures were collected every 28 d and feed intake was determined using the Insentec system. Residual feed intake was calculated by including BW, ADG, backfat thickness and ribeye area in the feed intake prediction model and at the end of the experiment, the extreme steers in RFI (12 Hi and 12 Lo) were selected. Steers were housed for another 60–70 d while being fed the same high moisture corn-based diet for calorimetric measurements and then slaughtered. Pancreases were subsampled, frozen in liquid nitrogen and stored at −80°C until analysis for lipase, α-amylase, and trypsin activities and protein concentration. Data were analyzed as a completely randomized design to test the effects of extremes for RFI on pancreatic enzymes. Data were tested for the significance using the CORR procedure and Tukey-Kramer multiple comparisons. Body weight, ADG, backfat thickness and ribeye area, and pancreatic lipase, α-amylase, and trypsin activity did not differ significantly ($P > 0.1$) between Hi and Lo RFI groups. However, pancreatic protein concentration (mg/g) tended to be significantly greater in Lo-RFI than Hi-RFI ($P = 0.09$). These data indicate that steers with Lo-RFI (greater efficiency) have lower pancreatic protein concentration than Hi-RFI steers but that pancreatic digestive enzyme activity did not differ between the 2 groups suggesting that in this experiment that pancreatic digestive enzyme activity was not associated with feed efficiency.

Key Words: feed efficiency, α-amylase, beef steers

304P Supplementing diets of early lactation Holstein dairy cows with peas and byproducts. J. W. Schroeder*, *North Dakota State University, Fargo.*

The objective was to evaluate the effects of combining byproducts and field peas on the yield and composition of milk from early lactating cows. Forty Holsteins (658 ± 49 kg BW, 1,459 ± 100 d of age, and 75 ± DIM) were stratified by parity and milk yield and assigned to pen (2 pens per treatment; control or byproduct) in a randomized complete block designed experiment. Diets were formulated to 18% CP and 1.62 Mcal of NEl per kg of dietary DM, 55 to 45 ratio of forage to concentrate, and similar dietary rumen degradable protein, lysine, and methionine concentrations. The control diet was composed of corn silage, alfalfa haylage, alfalfa hay, soybean meal, corn gluten meal, blood meal, vitamins, and minerals and fed as a total mixed ration. The treatment-fed diet replaced soybean meal with canola meal and reduced portions of corn gluten meal, while adding field peas, beet pulp pellets, corn distillers grains with solubles, wheat middlings, and soybean hulls in place of cracked corn. Fresh water was available at all times. Diets were mixed once, but delivered twice daily ensuring 5 to 10% refusal on an as-fed basis, access ensured with daily inspections. Cows were milked twice daily and milk samples collected at the onset and every 2 wk for 6 wk. Experimental protocols were approved by the university animal care and use committee and housed at the North Dakota State University Dairy Research Center. The treatment diet increased DMI ($P = 0.002$). No differences were noted for body condition score or body weight. Diets supplemented with 16% of DM as byproduct had similar ECM yield and milk composition. Rumen measures were similar except for a lower concentration of isobutyrate ($P = 0.01$) and greater total VFA ($P = 0.01$) for cows fed the treatment diet. While the physical particle length of the diets was regarded acceptable, and the 2 diets had similar physically effective fiber, rations formulated with 18% ADF may have contributed to a sporadic metabolic challenge isolated to 2 cows in one of the control pens, whereas cows consuming the treatment diet were not affected.

Key Words: ruminant, milk composition, byproducts

305P Periparturient ewe insulin efficiency and energetics: Manipulation via cereal management. A. Nikkhah*, *University of Zanjan, Zanjan, Iran.*

The objective was to determine effects of peripartal dietary cereal grain type and level on ewe insulin efficiency and lactation. Twenty cross-bred Afshari × Merino ewes (80.3 ± 2.0 kg BW) in a completely randomized design study were monitored from 24 d prepartum through 21 d postpartum. Ewes were housed indoor in individual boxes (1.5 × 2.5 m) and fed once daily at 0900 h mixed rations with higher or lower concentrate with either corn grain (CO) or a 50:50 ratio of wheat and barley grains (WB) with a 2 × 2 factorial arrangement of grain source and level. Forage to concentrate ratio in the higher grain diet was 60:40 prepartum, and 50:50 postpartum; while being respectively 70:30 and 65:35 in the lower grain diet. Dietary forage included 3:1 ratio of chopped alfalfa hay:corn silage. Data were analyzed as mixed models for repeated measures. Lambing DMI was increased with higher vs. lower WB (1.59 vs. 1.37 kg/d). The higher vs. lower CO (2.3 vs. 2 kg/d) and not WB (2 vs. 2 kg/d) improved postpartum DMI ($P < 0.05$). Feeding CO vs. WB, and feeding lower vs. higher level of both CO and WB increased fecal pH, suggesting reduced hindgut fermentation. Postpartal rumen pH was decreased by higher vs. lower WB (5.7 vs. 6.2, $P < 0.05$) and not CO (6.3 vs. 6.3). Rumen propionate was decreased (20.4 vs. 18.9 mmol/L), and acetate (67 vs. 70 mmol/L) and acetate to propionate ration (3.3 vs. 3.7) were decreased by feeding higher vs. lower grains. Colostrum properties, peripartal urine pH, lamb growth until 21 d of age, and placenta mass and expulsion time were unaffected. Milk yield (1.64 vs. 1.27 kg/d) and milk fat yield (99 vs. 81 g/d) were increased by feeding higher vs. lower grains. Plasma glucose was increased ($P < 0.05$) with higher vs. lower WB (57.6 vs. 52.2 mg/dL) and not CO (56 vs. 55 mg/dL). Feeding CO vs. WB reduced peripartal plasma NEFA (0.25 vs. 0.28 mmol/L), maintained insulin (0.38 vs. 0.36 ng/L), and thus increased insulin to NEFA ratio (2.47 vs. 1.77, $P < 0.05$), suggesting improved insulin efficiency. Dietary grain management provides opportunities to manipulate insulin efficiency, energy dynamics, and milk secretion of periparturient ewes.

Key Words: cereal, ewe, metabolism, periparturient

306P Feasibility of improving energy metabolism by feeding early-lactation cows less frequently. A. Nikkhah*, *University of Zanjan, Zanjan, Iran.*

Feasible feeding strategies are to help attenuate negative energy balance (NEB). The objective was to test a hypothesis that feeding frequency (FF) affects early lactation cows ability in maintaining blood insulin and thus in attenuating NEB. Eight multiparous Holstein cows (70 d in milk) housed in free individual boxes (4 × 3 m) were fed a TMR once daily (1 ×) at 0700 h, or 4 times daily (4 ×) at 0100, 0700, 1300 and 1900 h. The TMR was based on chopped alfalfa hay and a barley-corn based concentrate at 63% of diet DM. The TMR had 81% DM, 17.6% CP, and 27.3% NDF. The experimental design was a crossover with 2 periods of 20 d, each with 14 adaptation days. Data were analyzed as a linear mixed model with fixed treatment and square effects, and random cow, period and residual effects. The 1 × feeding increased DM intake (21.1 vs. 20.0 kg/d, $P = 0.05$), but milk NEL output (21.7 vs. 21.4 Mcal/d, $P = 0.72$), milk fat content (3.5 vs. 3.6%, $P = 0.66$), milk protein content (3.2 vs. 3.2%, $P = 0.81$), milk NEL to intake NEL ratio (0.60 vs. 0.62, $P = 0.35$), and fecal pH (6.64 vs. 6.62, $P = 0.67$) were similar between 1 × and 4 × , respectively. Urine pH was higher for 4 × than 1 × (8.12 vs. 8.00, $P < 0.01$). Serum glucose (57.9 vs. 58.0 mg/dL), urea (16.2 vs. 16.5 mg/dL), BHBA (498 vs. 467 μmol/L), albumin (3.4 vs. 3.4 g/dL), total protein (6.9 vs. 6.8 g/dL) and triglycerides (24.1 vs. 21.3 mg/dL) were similar between 1 × and 4 × , respectively. The first meal length (FML), starting from feed delivery until the first non-eating bout of ≥ 20 min, was 106 min in the 1 × cows and totally 49 min per feeding in the 4 × cows ($P < 0.01$). As such, serum insulin was increased (11 vs. 7 μIU/ml) and NEFA decreased (0.45 vs. 0.56 mmol/L) with 1 × feeding ($P < 0.05$). Therefore, under non-competitive individual housing, less frequent feeding elongated the first meal, increased feed intake, and reduced urine pH and serum NEFA. These enabled cows to maintain higher serum insulin levels that contributed to attenuated NEB.

Key Words: early lactation, feeding frequency, insulin, metabolism

307P Timing of feed delivery entrains periprandial rhythms of rumen ammonia and peripheral urea in dairy cows. A. Nikkhah*, *University of Zanjan, Zanjan, Iran.*

The objective was to establish circadian and periprandial rhythms of rumen ammonia (RA) and peripheral blood urea (BU) in response to feeding time in lactating dairy cows. Four multiparous and 4 primiparous lactating Holsteins (82 d in milk) were used in a crossover design study with 2 6-wk periods, each with 4-wk of adaptation. A TMR with 49.8% concentrate was delivered at either 0900 h or at 2100 h to permit 5 to 10% orts. Jugular blood was sampled via catheters every 2 h for two 24-h periods during wk 5 of each period. Feed intake was monitored continuously using a data acquisition setting. Data were analyzed as mixed models for repeated measures. The proportion of daily TMR intake consumed within 3-h post-feeding was 55% in cows fed at 2100 h, and 46% in cows fed at 0900 h ($P < 0.05$). RA was higher at 2 h but lower at 6 h post-feeding ($P < 0.05$) and remained relatively lower ($P < 0.10$) between 6 and 20 h post-feeding in cows fed at 2100 h instead of at 0900 h. Feeding time did not affect daily averages of BU. BU increased significantly shortly post-feeding in the morning-fed cows but not in the evening-fed cows. BU was higher for about 12 h pre-feeding in evening vs. morning fed cows ($P < 0.01$). Results establish that time of feeding and, thus, time of major eating entrains periprandial and circadian rhythms of feed intake, RA, and BU in once-daily-fed cows. Time of feeding/eating can therefore affect splanchnic and peripheral nitrogen metabolism and efficiency in high-producing lactating cows.

Key Words: circadian rhythm, blood urea, rumen ammonia, Holstein cow

308P Feed presentation time and diet effects on postprandial patterns of peripheral urea in once-daily-fed lactating dairy cows. A. Nikkhah*, *University of Zanjan, Zanjan, Iran.*

The objective was to determine effects of feed presentation time and dietary forage to concentrate ratio on postprandial patterns and daily averages of peripheral blood urea (BU) in lactating dairy cows. Four multiparous (BW = 652 ± 14 kg; BCS = 2.87 ± 0.14, days in milk = 83 ± 22) and 4 primiparous (BW = 667 ± 110 kg, BCS = 3.19 ± 0.66, days in milk = 81 ± 23; mean ± SD) Holsteins were utilized in a 4 × 4 Latin square design study with a 2 × 2 factorial arrangement of feeding time and diet type. A higher concentrate (HC, forage to concentrate ratio = 38.5:61.5) or a lower concentrate (LC, forage to concentrate ratio = 50.6:49.4) TMR was presented at either 2100 h or 0900 h. The study had 4 21-d periods, each with 14-d of adaptation. Blood was sampled every 2-h via jugular catheters for 2 24-h periods during sampling weeks. Feeding at 2100 h vs. 0900 h increased feed intake within 3-h post-feeding, from 26% to 37% of total daily intake ($P < 0.05$), but did not affect total daily intake. BU exhibited significant circadian patterns in both parities, which depended on diet type and its interactions with time of feeding. Postprandial BU levels were higher for cows fed the LC diet, but not the HC diet, at 0900 h instead of at 2100 h. Feeding the HC vs. LC diet tended to increase average daily BU (4.9 vs. 4.7 mmol/L, $P < 0.10$). Feeding time did not affect average BU. Results demonstrated that time of feed presentation orchestrated postprandial and circadian patterns of feed intake and BU in once-daily-fed lactating cows. Time of major eating activity and its interaction with diet can, therefore, affect splanchnic and peripheral nitrogen assimilation in dairy cows.

Key Words: blood urea, circadian pattern, feed presentation time, lactating cow

309P Response of different concentrations and sources of dietary protein on lactating dairy cows. I. Acharya*, D. Schingoethe, and K. Kalscheur, *Dairy Science Department, South Dakota State University, Brookings.*

A study was conducted to determine the response of feeding 2 different concentrations (15% and 17%) and sources of protein [canola meal (CM) and high protein dried distillers grain (DG)]. Sixteen lactating Holstein cows (4 primiparous and 12 multiparous) were fed in a 4 × 4 Latin square with 2 × 2 factorial arrangement of treatments. Each period was 4 wks and data were collected during wk 3 and 4 of each period. Diets were formulated with 15% CP with CM (15CM), 15% CP with DG (15DG), 17% CP with CM (17CM) and 17% CP with DG (17DG). All diets contained 55% forage (50% alfalfa hay and 50% corn silage) and 45% concentrate and all with 4.08% ether extract. DMI (kg/d) was similar ($P > 0.33$) between sources (25.0 vs. 25.5 for CM and DG respectively) but different ($P = 0.03$) between concentrations (24.6 vs. 25.9 for 15 and 17% CP respectively). Milk yield (kg/day) was similar between sources (34.9 vs. 35.5) but greater ($P = 0.002$) for cows fed 17% CP diets (34.0 vs. 36.4). Milk fat % was greater ($P = 0.02$) for cows fed 17% CP (3.14) compared with 15% CP (2.97) diets but similar between sources (3.05 vs. 3.06). Milk protein % (3.11 vs. 3.09), SCC (273 vs. 225) and lactose % (4.82 vs. 4.88)

were different ($P < 0.05$) between protein sources but similar between concentrations. MUN (mg/dl) was greater ($P < 0.01$) for cows fed 17% CP and DG ($P = 0.01$) as compared with 15% CP (10.7 vs. 7.1) and CM (9.3 vs. 8.6). Fat yield (1.01 vs. 1.14), protein yield (1.05 vs. 1.13), lactose yield (1.65 vs. 1.77), fat-corrected milk (28.8 vs. 31.7) and energy-corrected milk (31.8 vs. 34.8) in kg were higher ($P < 0.01$) with 17% CP diets but not different between protein sources. Fat-corrected milk FE (1.18 vs. 1.25) and energy-corrected milk FE (1.30 vs. 1.37)) were greater in cows fed 17% CP ($P < 0.05$) than 15% CP but similar between protein sources ($P > 0.05$). Average body weight (683 kg) and body condition score (3.07) for the experiment were not affected ($P > 0.05$) by the treatments. We concluded that use of CM or DG for the lactating dairy cows had same effect on production but protein concentrations in diets had great effect on production.

Key Words: canola meal, high protein dried distillers grain, lactating dairy cows, milk

310P The influence of feed intake on hepatic oxygen consumption, citrate synthase activity and protein concentration in pregnant beef cows. B. J. Awda*[1], K. M. Wood[1], L. Trouten-Radford[1], B. W. McBride[1], S. P. Miller[1], I. B. Mandell[1], C. J. Fitzsimmons[2,3], and K. C. Swanson[4], *[1]Department of Animal & Poultry Science, University of Guelph, Guelph, ON, Canada, [2]Agriculture & Agri-Food Canada, Edmonton, AB, Canada, [3]Department of Agriculture, Food, and Nutritional Science, University of Alberta, Edmonton, AB, Canada, [4]Department of Animal Sciences, North Dakota State University, Fargo.*

The objective of this study was to examine hepatic oxygen consumption, citrate synthase activity and protein concentration in pregnant beef cows with differing feed intakes (FI). In this study, 24 mature, pregnant, cross-bred cows [3–5 yr old; 639 ± 68 kg (mean ± SD)] predominantly of Angus and Simmental breeds were individually-fed for 100 ± 13.1 (mean ± SD) d a haylage/wheat straw-based diet at 85% (Lo-FI; n = 12) and 140% (Hi-FI; n = 12) of their NE_m requirements. Body weights were measured every 14 d and FI was monitored using Calan gates. Feed intake was adjusted relative to BW every 14 d. At the end of the experiment (approximately d 245 of pregnancy), cows were slaughtered; livers were weighed and hepatic tissue samples were placed in ice-cold fortified Krebs-Ringer bicarbonate buffer and transferred immediately to the laboratory for oxygen consumption analysis. A sample was also frozen in liquid nitrogen and stored at −80°C until analysis for citrate synthase activity (as a marker for mitochondrial biogenesis) and protein concentration. Liver weight ($P < 0.05$), oxygen consumption [mL/g protein/h, mL/liver/h ($P \leq 0.05$), mL/kg BW/h ($P = 0.10$)], and citrate synthase activity [U/g; ($P = 0.10$), U/g of liver protein, KU/liver ($P < 0.10$)] of Hi-FI cows were greater than that of values for Lo-FI cows. However, hepatic protein concentration (mg/g) was greater in the Lo-FI than Hi-FI group ($P = 0.07$). These data indicate that increasing FI in pregnant cows increases hepatic oxygen consumption and citrate synthase activity.

Key Words: feed intake, oxygen consumption, citrate synthase

311P Effects of protein intake in late gestation beef cows on progeny postnatal growth and carcass traits. A. E. Radunz*[2], F. L. Fluharty[1], G. D. Lowe[1], and S. C. Loerch[1], *[1]The Ohio State University, Wooster, [2]University of Wisconsin-Madison, Madison.*

Mature Angus-cross (n = 84) beef cows (initial BW = 489 ± 44 kg) were used to determine the effects of maternal protein intake in limit fed corn or dried distillers grains late gestation diets on subsequent progeny growth and carcass traits. Cows were blocked by weight (n = 4) and stratified by body condition score, fetus sire, and age and randomly assigned to 1 of 4 pens/treatment. Cows were adapted to diets starting at 155 d of gestation and fed until 1 wk before expected calving date. Cows were fed 1 of 3 diets: limit-fed dried distillers grains (DGS; 1255 g/d CP); limit-fed corn without supplemental protein (LPC; 575 g/d CP) and limit-fed corn diet with supplemental protein similar to DGS diet (HPC; 1230 g/d CP). Cow BW and BCS were collected every 21 d and DMI of cows fed LPC and HPC were adjusted to have similar BW gain to cows fed DGS during late gestation. Following parturition, cows and progeny were fed a common diet and managed as 1 group. Progeny were weaned at 187 ± 3.7 d of age and a subset of progeny (n = 52) were fed a finishing diet and then slaughtered at 1.7 ± 0.1 cm 12th rib fat thickness. By design, cow initial and final BW were similar ($P \geq 0.33$) among treatments, resulting in similar ($P \geq 0.51$) ADG during late gestation. Progeny birth BW was greater ($P = 0.03$) in calves from cow fed DGS (38.5 kg) than calves from cows fed HPC (35.9 kg) or LPC (36.8 kg), however at weaning no differences were detected ($P = 0.17$) in BW among treatments. Feedlot performance (final BW, ADG, DMI, G:F) was not different ($P = 0.16$) among treatments, while there was a trend ($P = 0.10$) for calves from cows fed HPC to be older at slaughter than calves from cows fed DGS or LPC. Calves from cows fed HPC tended to have heavier ($P = 0.09$) HCW than calves from cows fed DGS or LPC, but no differences were detected ($P \geq 0.12$) in LM area, 12th rib fat thickness, yield grade, and marbling score. In this experiment, source and amount of protein fed to beef cows starting at 155 d of gestation had little effect on feedlot performance or carcass traits of progeny, despite effects on birth BW.

Key Words: beef cattle, gestation, protein intake, fetal programming

312P The influence of feed intake on pancreatic lipase, α-amylase, and trypsin activities in pregnant beef cows. B. J. Awda*[1], K. M. Wood[1], B. W. McBride[1], S. P. Miller[1], I. B. Mandell[1], C. J. Fitzsimmons[2,3], and K. C. Swanson[4], *[1]Department of Animal & Poultry Science, University of Guelph, Guelph, ON, Canada, [2]Agriculture & Agri-Food Canada, Edmonton, AB, Canada, [3]Department of Agriculture, Food, and Nutritional Science, University of Alberta, Edmonton, AB, Canada, [4]Department of Animal Sciences, North Dakota State University, Fargo.*

The objective of this study was to examine pancreatic lipase, α-amylase, and trypsin activities in beef cows with differing feed intakes (FI). In this study, 24 mature, pregnant, cross-bred cows [3–5 yr old; 639 ± 68 kg (mean ± SD)] predominantly of Angus and Simmental breeds were individually-fed for 100 ± 13.1 (mean ± SD) d a haylage/wheat straw-based diet at 85% (Lo-FI; n = 12) and 140% (Hi-FI; n = 12) of their NE_m requirements. Body weights were measured every 14 d and FI was monitored using Calan gates. Feed intake was adjusted relative to BW every 14 d. At the end of the experiment (approximately d 245 of pregnancy), cows were slaughtered, pancreases were weighed, subsampled, frozen in liquid nitrogen and stored at −80°C until analysis for lipase, α-amylase, and trypsin activities and protein concentration. α-Amylase ($P < 0.001$) and trypsin [U/g, KU/Pancreas ($P < 0.05$), U/kg of BW ($P = 0.10$)] activities of Hi-FI cows were greater than that of values for Lo-FI cows. However, pancreatic protein concentration (mg/g) and lipase activity did not differ between Hi and Lo-FI groups ($P > 0.10$). These data indicate that pregnant cows with Hi-FI have greater pancreatic α-amylase and trypsin activities, suggesting that they may have increased capacity for small intestinal hydrolysis of starch and protein digestion than Lo-FI pregnant cows.

Key Words: feed intake, pancreatic lipase, beef cows

313P Feedlot performance and quality grade of steers subject to two feedlot entry weights following supplementation in the backgrounding period. M. C. Westerhold*, W. J. Sexten, M. S. Kerley, J. W. Rickard, and B. R. Wiegand, *University of Missouri, Columbia.*

One hundred and 79 crossbred steers were used in a completely randomized design to evaluate feedlot entry weight and diet effect on performance and carcass characteristics. Prior to feedlot entry steers grazed tall-fescue pastures with access to average quality grass hay. Steers were fed 1.53 kg·hd^{-1}·d^{-1} (DM basis) of a corn/soybean meal supplement. Steers were randomly assigned to either light (LT) = BW 311 ± 2.7 kg or heavy (HV) = BW 377 ± 3.2 kg weight group before feedlot entry. Steers were then randomly assigned to either corn (C) or soybean hull (SH) based finishing diet. Cattle were harvested upon reaching a 12th rib fat thickness of 1.27 cm, as estimated by visual appraisal. LT final weight (538 kg) was less ($P < 0.05$) than HV at the same ($P = 0.28$) 12th rib fat endpoint (569 kg). HV reached slaughter endpoint earlier ($P < 0.05$) with 117 d on feed (DOF) compared with LT with 145 DOF. LT ADG (1.57 kg/d) was less than ($P < 0.05$) HV (1.64 kg/d). Dressing percentage was greater ($P < 0.05$) for LT (63.6%) compared with HV carcasses (62.9%). 12th rib fat depth did not differ between LT (1.32 cm) and HV (1.37 cm). LT carcasses had greater ($P < 0.05$) REA cm ^{2}/45.5kg hot carcass weight compared with HV carcasses (11.2 vs 10.57, respectively). LT had lower ($P < 0.05$) calculated YG (2.98) than HV (3.18). An interaction ($P = 0.005$) for marbling score was observed, within LT, C (510) did not differ from SH (493), HV, C (511) did not differ when compared with SH diets (527). In C diets feedlot entry weight did not influence marbling score. However, in SH diets marbling score was increased by heavier feedlot entry weight. The results of this study indicate that increased weight at feedlot entry resulted in less DOF, greater final BW, increased ADG, and marbling score (within SH diets) while lighter feedlot entry weight resulted in increased DP, lower YG, and increased REA/CWT.

Key Words: beef cattle, backgrounding, yield/quality grade, by-product feed

314P Effect of soy hull inclusion on diet digestibility. J. R. Russell*, N. F. Johnson, J. H. Porter, and M. S. Kerley, *University of Missouri, Columbia.*

Five diets with increasing soy hull (SH) to corn proportions (20, 60, 80, 90, and 100% SH) were fed to continuous culture fermenters to determine the effect of increasing fiber inclusion on digestibility and microbial efficiency (MoEff). The 5 diets were randomly distributed over 24 fermenters, acclimated for 4 d, and fermenter and effluent samples were then collected for 3 d. NDF digestibility responded linearly ($P < 0.05$) with the highest value from the 100 diet. Analysis of OM digestibility (OMd) and DM digestibility (DMd) generated cubic responses ($P < 0.05$). The OMd of 20 was higher ($P < 0.05$) than that of 60 and 100, however none of the 4 higher SH diets differed. Similarly, the DMd of 20 was higher ($P < 0.05$) than the other diets which were similar. Nitrogen digestibility was higher ($P < 0.05$) for 20 than 100. Bacterial Nitrogen flow out of the fermenter responded linearly ($P < 0.05$) and was highest ($P < 0.05$) for 20. MoEff responded linearly ($P < 0.05$), decreasing as SH increased. Diets 20 and 60 did not differ in MoEff, but 20 was higher ($P < 0.05$) than the other diets which were similar to diet 60. Lactic acid (LAC) and VFA were measured at intervals of 0, 4, and 8 h post-feeding. Acetate (ACE), propionate (PRO), and total VFAs (TVFA) were all higher ($P < 0.05$) for hours 8 and 4 versus 0, while ACE:PRO Ratio (APR) was lower ($P < 0.05$) for hour 8 versus 0. Hours 4 and 8 did not differ. PRO, APR, Butyrate, and TVFA responded quadratically ($P < 0.05$) to SH inclusion. ACE increased linearly ($P < 0.05$) as SH inclusion increased. LAC had a cubic response ($P < 0.05$) to SH inclusion and was highest ($P < 0.05$) for 20 and 60. It was hypothesized that fiber digestibility would respond quadratically to starch level in the diet and influence microbial protein flow and MoEFF accordingly, with a breakpoint where the fiber:starch ratio may benefit from methods to enhance fiber digestion. It is concluded that fiber digestion is reduced across the range of starch inclusion rates, and efforts to increase fiber digestibility could provide benefit at higher levels of fiber inclusion.

Key Words: digestibility, fermentation, soy hull

315P Influence of nutrient restriction and melatonin supplementation of pregnant ewes on maternal and fetal pancreatic α-amylase and trypsin activity. K. C. Swanson*[1], A. M. Meyer[2], C. O. Lemley[1], J. S. Caton[1], and K. A. Vonnahme[1], *[1]North Dakota State University, Fargo, [2]University of Wyoming, Laramie.*

Thirty-two primiparous ewes were used to determine the effect of maternal nutrient restriction (60% or 100% of requirement) and melatonin supplementation (0 or 5 mg/d) on pancreatic α-amylase and trypsin activity. Dietary treatments were initiated at d 50 of gestation and fed until d 130 when ewes were euthanized. The pancreas was removed from ewes and fetuses, trimmed of mesentery and fat, weighed, and a sample snap-frozen in liquid N and stored at −80°C until analysis for α-amylase and trypsin activity. Data were analyzed as a completely randomized design with a 2 × 2 factorial arrangement of treatments using the mixed procedure of SAS. Pancreatic mass (g) was greater ($P < 0.001$) in ewes fed at 100% of requirements compared with ewes fed at 60% of requirements. Pancreatic mass (g and g/kg BW) was greater ($P \leq 0.04$) in ewes supplemented with melatonin. Pancreatic α-amylase activity (U/g, U/pancreas, and U/kg BW) was greater ($P < 0.001$) in ewes fed at 100% of requirements compared with ewes fed at 60% of requirements and tended to be greater ($P \leq 0.10$) in ewes supplemented with melatonin. Concentration of pancreatic trypsin activity (U/g) in ewes was not influenced ($P > 0.29$) by nutrient restriction or melatonin supplementation. Because of differences in pancreatic mass, total pancreatic trypsin activity (U/pancreas) was greater ($P = 0.002$) in ewes fed at 100% of requirements compared with ewes fed at 60% of requirements and was greater ($P = 0.02$) in ewes supplemented with melatonin. Fetal pancreatic mass and α-amylase and trypsin activity were not influenced by nutrient restriction or melatonin supplementation of ewes. These data indicate that nutrient restriction decreases maternal pancreatic mass and the concentration of α-amylase activity, melatonin supplementation increases maternal pancreatic mass, but nutrient restriction does not influence fetal pancreatic mass or α-amylase and trypsin activity.

Key Words: digestive enzymes, nutrient restriction, melatonin, sheep

316P Effects of hay supplementation in corn and dried distillers grains-based diets on performance and rumen metabolism in feedlot cattle. L. A. Morrow*[1], T. L. Felix[2], F. L. Fluharty[1], S. A. Metzger[1], and S. C. Loerch[1], *[1]The Ohio State University, Wooster, [2]University of Illinois, Urbana.*

Sulfuric acid in dried distillers grains (DDGS) may increase the risk of acidosis and polioencephalomalacia. The objectives of this research were to determine the effects of hay (7 or 14%) and energy source (corn or DDGS) on 1) performance, and 2) ruminal pH, H_2S, short chain fatty acids (SCFA), and in situ DM disappearance (ISDMD) of

soy hulls. Exp. 1: Angus cross cattle (n = 72; BW = 253 ± 25 kg) were blocked by BW and allotted in a 2 × 2 factorial arrangement of treatments to 12 pens. Dietary treatments were: 1) 7% hay and 78% cracked corn, 2) 14% hay and 71% cracked corn, 3) 7% hay and 60% DDGS, 4) 14% hay and 60% DDGS. The remainder of the diets was cracked corn and 15% supplement. There were no interactions ($P > 0.30$) of hay and energy source for DMI, ADG, final BW, or G:F. Supplementation with hay did not affect ($P > 0.30$) DMI, ADG, G:F, or final BW. Cattle fed DDGS had 5.7% reduced DMI, 2.7% decreased final BW ($P > 0.15$), and tended to have decreased ($P < 0.08$) ADG compared with those fed corn. Exp. 2: Rumen fistulated heifers (n = 8; BW = 735 ± 32 kg) were used in a replicated 4 × 4 Latin Square design and randomly assigned to the diets used in Exp. 1. Supplemental hay increased mean rumen pH from 0 to 12 h for both energy sources, but more so for heifers fed DDGS than for those fed corn (interaction; $P < 0.02$). Supplemental hay tended to increase ($P < 0.08$) rumen pH at 0, 1.5, and 3 h post-feeding but did not affect ($P > 0.14$) pH at 6, 9, or 12 h post-feeding. Rumen sulfide and H_2S gas concentrations were greater from 0 to 12 h post-feeding in heifers fed DDGS-based diets ($P < 0.01$); however, hay supplementation did not affect ($P > 0.15$) sulfide or H_2S concentrations. Heifers fed DDGS had lower ($P < 0.01$) total SCFA and greater ($P < 0.01$) A:P than those fed corn. The average ISDMD of soy hulls was 36% greater ($P < 0.01$) for heifers fed DDGS than those fed corn. Increasing supplemental hay to 14% of the diet did not improve performance of cattle fed corn or DDGS-based diets. However, supplemental hay tended to improve rumen pH and measures of fiber digestion.

Key Words: distillers grains, forage supplementation, feedlot cattle

317P The responses of animal growth and feed efficiency to diet ammonia-nitrogen and post-ruminal arginine supply. Y. Liang*, W. J. Sexten, and M. S. Kerley, *University of Missouri, Columbia.*

A growth study using 80 steers was conducted to determine effect of rumen degradable nitrogen (RDN) supply at 2 levels of post-ruminal amino acid supply. Effect of roughage inclusion (10%) was also measured. There was no significant difference on ADG, DMI and feed to gain ratio between levels of post-ruminal arginine supply. Feed to gain ratio would not be optimized until post-ruminal arginine requirement was met. Therefore, post-ruminal arginine status in all diets were sufficient to meet requirement, explaining why no differences between proposed insufficient/sufficient post-ruminal arginine treatment occurring. Urea was used in diets to increase RDN level in the rumen. DMI was greater ($P < 0.05$) in diets including urea than diets without urea and feed to gain ratio had a similar response (5.8 vs. 5.5 for urea and non-urea diets, respectively; $P < 0.1$). In this study RDN level in diets was estimated to be deficient by 1.86% of diet CP. Because growth and efficiency was not improved by urea addition, recycled nitrogen was capable of supplying the calculated deficiency of dietary RDN to ruminal microbes. Because excess nitrogen added by urea would have become ammonia, greater energy was need in diets with urea to convert excess ammonia into urea. The increased need for energy resulted in greater DMI in these diets and poorer feed efficiency. Four of the diet treatments contained no roughage and were compared with a conventional diet with 10% roughage. Roughage inclusion increased DMI (10.1kg vs. 8.9 kg for with roughage and non-roughage diet respectively; $P < 0.01$) and feed to gain ratio (6.5 vs. 5.6 for with roughage and non-roughage diet respectively; $P < 0.01$). It was concluded that feed efficiency would not be maximized until RDN was met, and that overfeeding RDN in the form of non-protein nitrogen can reduce efficiency. Removing roughage could increase feed efficiency for feedlot cattle, being well agreement with the previous studies in our lab.

Key Words: feed efficiency, post-ruminal arginine, RDN

318P Effect of increasing distillers grains inclusion on performance and carcass characteristics of early-weaned steers. J. P. Schoonmaker*, M. C. Claeys, and R. P. Lemenager, *Purdue University, West Lafayette, IN.*

Ninety Angus × Simmental cross steers were weaned at 134 d of age (early-weaned: EW) and allotted by BW (199.7 ± 12.2 kg) to 3 high concentrate diets (20% corn silage) containing either 0, 30, or 60% distillers grains (DGS) diets. Diets contained 16.9, 16.8, and 22.1% CP, respectively. Dietary treatments were fed for 99 d, after which steers were placed on a common diet containing no DGS (12.8% CP) for 130 d until slaughter. Concentration of dietary DGS did not affect ADG, DMI, or G:F during the growing phase ($P > 0.41$), did not produce any carryover effects on ADG, DMI, or G:F during the finishing phase ($P > 0.26$), and resulted in similar overall performance ($P > 0.52$). Dressing percentage (61.4, 61.6, 60.2%; $P < 0.05$), hot carcass weight (367.4, 370.4, 361.3 kg; $P < 0.02$), fat thickness (1.42, 1.53, 1.27 cm; $P < 0.10$), LM area (81.5, 83.4, 80.1 cm2; $P < 0.10$), and % KPH (2.0, 2.2, 2.1%; $P < 0.10$) responded quadratically to early DGS supplementation, increasing from 0 to 30% DGS inclusion and decreasing from 30 to 60% DGS inclusion, respectively. Marbling score was not affected ($P > 0.46$) by DGS inclusion, but the partitioning of fat from the subcutaneous (SC) to intramuscular (IM) fat depot was altered by DGS inclusion ($P < 0.10$). The ratio of IM to SC fat decreased from 0 to 30% DGS inclusion and increased from 30 to 60% DGS inclusion. In addition, the percentage of cattle grading choice- responded quadratically (40.2, 26.7, 62.3%; $P < 0.10$), decreasing from 0 to 30% DGS inclusion and increasing from 30 to 60% DGS inclusion, respectively. This study suggests that EW cattle perform similarly to normal-weaned cattle when high concentrations of DGS are fed, but experience a partitioning of carcass to non-carcass components when DGS was fed at a rate of 60%. However, EW steers also experienced a beneficial partitioning of fat away from the SC to IM fat depot when DGS was fed at a rate of 60% early in the feeding period. Utilization of carcass fat as an energy source for disposal of excess N may be responsible for changes in carcass weight and fat deposition.

Key Words: beef cattle, early weaning, distillers grains, marbling

319P Performance and gastrointestinal parasite control by Boer goats offered a synthetic anthelmintic or natural herbs while grazing during the summer. H. A. Swartz*, A. N. V. Stewart, J. D. Caldwell, and B. C. Shanks, *Lincoln University, Jefferson City, MO.*

With increasing concerns that gastrointestinal parasites are becoming resistant to synthetic anthelmintics, finding an alternative for control is important. Our objective was to determine the effects natural herbs have on performance and gastrointestinal parasite loads in Boer goats while grazing during the summer. Boer does (n = 151) were stratified by body weight and age and allocated randomly to 1 of 15 groups representing 3 treatments: 1) control (C); 2) natural herbs (5.5 g/hd/d; NH); and 3) synthetic anthelmintic (4.5 mL/kg body weight; SA). Beginning body weight, fecal egg counts (FEC), packed cell volume (PCV), and ending FAMACHA scores did not differ ($P \geq 0.39$) across treatments, whereas beginning FAMACHA scores were greater ($P < 0.05$) from NH vs. SA. Ending body weights tended ($P = 0.06$) to be greater from NH vs. SA and average daily gain and total weight gains

were greater ($P < 0.05$) from NH vs. SA. Ending FEC were greater ($P < 0.05$) from C vs. NH and SA, and ending PCV were greater ($P < 0.05$) from NH and SA vs. C and from SA vs. NH. Fecal egg count change from beginning to end tended ($P = 0.10$) to be greater and PCV change was greater ($P < 0.05$) from C vs. NH and SA. Therefore, natural herbs may improve performance and may be beneficial for controlling gastrointestinal parasites in Boer does grazing during the summer.

Key Words: anthelmintics, goats, parasites

320P Performance and gastrointestinal parasite control by Katahdin hair sheep offered a synthetic anthelmintic or natural herbs while grazing during the summer. H. A. Swartz*, A. N. V. Stewart, J. D. Caldwell, and B. C. Shanks, *Lincoln University, Jefferson City, MO.*

Synthetic anthelmintics for controlling gastrointestinal parasites in sheep are becoming ineffective. Substituting synthetic anthelmintics with natural herbs may alleviate this problem; however, data supporting this hypothesis is limited. Our objective was to determine if natural herbs would improve performance and reduce gastrointestinal parasites in Katahdin hair sheep grazing during the summer. Katahdin ewes (n = 144; 66 ± 0.8 kg average beginning body weight) were stratified by body weight and age and allocated randomly to 1 of 15 groups representing 3 treatments: 1) control (C); 2) natural herbs (5.5 g/hd/d; NH); and 3) synthetic anthelmintics (4.5 mL/kg body weight; SA). Beginning body weight, fecal egg counts (FEC), packed cell volume (PCV), and FAMACHA scores did not differ ($P \geq 0.31$) across treatments. At the end of the grazing period, body weight tended ($P = 0.06$) to be greater, and average daily gain and total weight gains were greater ($P < 0.05$) from NH compared with SA, but ending FEC, PCV, and FAMACHA scores did not differ ($P \geq 0.17$) across treatments. Fecal egg count, PCV, and FAMACHA score change from beginning to the end of the grazing period also did not differ ($P \geq 0.15$) across treatments. Therefore, natural herbs may improve body weight gain, but may not alter gastrointestinal parasites in Katahdin hair sheep grazing during the summer.

Key Words: anthelmintics, parasites, sheep

321P Performance by Katahdin ram lambs grazing mixed turnip and oat pastures in late spring through early summer using either continuous or rotational grazing schemes: 1-year summary. G. T. Otto*, J. D. Caldwell, B. C. Shanks, M. J. Singer, H. A. Swartz, A. N. V. Stewart, E. A. Backes, K. R. Ness, and D. K. Sommerer, *Lincoln University, Jefferson City, MO.*

Cool-season annual forages and brassicas may provide a high plane of nutrition for growing lambs; however, these effect are not well documented in late spring through early summer. Therefore, our objective was to determine the effects of grazing mixed turnip (*Brassica. rapa* L. ssp. *rapa*) and oat (*Avena sativa*) pastures in late spring through early summer using different rotational grazing frequencies, on performance by Katahdin ram lambs. Beginning May 31, Katahdin ram lambs (n = 31; 28 ± 1.9 kg initial body weight) were stratified by body weight and allocated randomly to one of 9 0.20-ha pastures representing 3 treatments: 1) continuous (C; 3 replications); 2) 2-cell rotation (2R; 3 replications); or 3) 3-cell rotation (3R; 3 replications). Pastures were grazed for approximately 23 d at a stocking rate of 17 Katahdin ram lambs/ha. All 2R and 3R pastures were rotated based on available forage. Final body weight, ADG, and total body weight gain did not differ ($P \geq 0.68$) across treatments. Final FAMACHA scores did not differ ($P = 0.60$) across treatments. Therefore, 2-cell or 3-cell rotational grazing of mixed turnip and oat pastures in late spring through early summer may not improve Katahdin ram lamb performance compared with continuous grazing.

Key Words: Katahdin ram lambs, oats, turnips

322P Essential oils effects on rumen fermentation and biohydrogenation. A. Ishlak*[1], M. Gunal[2], and A. AbuGhazaleh[1], *[1]Southern Illinois University, Carbondale, [2]Süleyman Demirel University, Turkey.*

The effects of 6 essential oils (EO) on rumen fermentation and biohydrogenation were evaluated under in vitro conditions. Three doses (125, 250, and 500 mg/L) of 6 EO were evaluated using in vitro 24-h batch culture of rumen fluid with a 55:45 forage:concentrate diet. Treatments were control (CO), citronella oil (CI) clove oil (CL), pine oil (PI), rosemary oil (RO), sage oil (SA), and thyme oil (TY). Treatments were incubated in triplicate in 125 mL flasks containing 500 mg finely ground TMR, 25 mg soybean oil, 10 mL of the strained ruminal fluid, 40 mL of media, and 2 mL of reducing solution. After 24 h, the pH was determined, and samples were collected to analyze ammonia-N, volatile fatty acids (VFA) and fatty acids. Cultures pH was not affected by EO averaging 6.6 ± 2.1. Relative to the CO, ammonia-N concentration decreased ($P < 0.05$) with EO, particularly with the high doses of CI, PI, and SA. Except for SA and RO, EO additional at high doses reduced ($P < 0.05$) total VFA concentrations relative to the CO. EO had minor to no effects on the proportions of acetate, propionate and butyrate. Relative to CO, the addition of CI and PI increased ($P < 0.05$) the proportions of isobutyrate and decreased ($P < 0.05$) the proportions of valerate and isovalerate. The concentrations (mg/culture) of C18:0 and C18:1 trans fatty acids decreased ($P < 0.10$) with CI, PI, RO and SA relative to the CO. Most tested EO in this study; however, had little to no effects on conjugated linoleic acid and linoleic acid concentrations. In conclusion, results from this study show that EO tested in this study had moderate effects on rumen fermentation and biohydrogenation particularly when added at higher doses.

Key Words: essential oil, rumin, fermentation, biohydrogenation

323P Performance by crossbred wether lambs with continuous or rotational access to mixed turnip and oat pastures in late spring through early summer: 1-year summary. K. R. Ness*, J. D. Caldwell, B. C. Shanks, M. J. Singer, H. A. Swartz, A. N. V. Stewart, E. A. Backes, G. T. Otto, and D. K. Sommerer, *Lincoln University, Jefferson City, MO.*

Cool-season annual forages can provide high-quality feedstuffs for growing lambs, but these effects are not well documented in late spring through early summer. Our objective was to determine the effects of grazing mixed turnip (*Brassica rapa* L. ssp. *rapa*) and oat (*Avena sativa*) pastures in late spring through early summer using different rotational grazing schemes, on performance by crossbred wether lambs. Crossbred wether lambs (n = 24; 31 ± 2.3 kg initial body weight) were stratified by body weight and allocated randomly to 1 of 9 groups. Six groups contained 3 wether lambs each and 3 groups contained 2 wether lambs each. Groups were assigned randomly to 3 treatments: 1) continuous (C; 3 replications), 2-cell rotation (2R; 3 replications), or a 3-cell rotation (3R; 3 replications). All pastures were 0.20 ha and both 2R and 3R replications were rotated based on available forage. Put-and-take grazing was used to manage excess available forage in each replication. Final weight, ADG, and total body weight gain did not differ ($P \geq 0.54$) across treatments. Final FAMACHA scores (an indicator of anemia) tended to be greater ($P = 0.08$) from C

compared with 2R and 3R (3 versus 2 average, respectively). Therefore, grazing mixed turnip and oat pastures in late spring through early summer using either a 2-cell or 3-cell rotation may not improve crossbred wether lamb performance compared with continuous grazing, but may lower FAMACHA scores.

Key Words: crossbred wether lambs, oats, turnips

324P Drying methods of in situ residue of fat coated butyrate. K. J. Herrick*[1], A. R. Hippen[1], S. D. Ranathunga[1], J. L. Anderson[1], K. F. Kalscheur[1], S. C. Moreland[2], and J. E. van Eys[2], *[1]South Dakota State University, Brookings, [2]Nutriad Inc., Elgin, IL.*

Previous research from our laboratory has indicated that supplementing lactating dairy cows with butyrate has positively affected blood and rumen parameters associated with glucose and lipid metabolism. Our research has also demonstrated that when sodium butyrate is singly dosed in the rumen, a large portion of butyrate is converted to ketone bodies by the rumen epithelium within 8 h of dosing. Thus, it would be beneficial to provide a source of butyrate that was resistant to rumen degradation. However, because of the volatility of butyrate and the potential loss related to residue drying methods, determining the escape properties of butyrate products through an in situ trial proved to be difficult. Therefore, the objective of this research was to evaluate drying methods of in situ residue to accurately determine butyrate and dry matter loss associated with rumen degradation. A fat-coated butyrate (CB) product developed to improve the physical and handling characteristics of butyrate was selected as the source of butyrate for all treatments. Dacron bags (10 × 20 cm) containing approximately 5 g of CB were inserted into 2 lactating Holstein cows previously fitted with rumen cannulas. Duplicate bags for each drying treatment were incubated for 48, 24, 8, 4, 2, and 0 h. Following removal from the cows, the bags were gently hand washed in cold water and then dried for 48 h in one of the following methods: heat (55°C) and forced air (HF), heat (55°C) (H), freezing followed by forced air (FF), forced air (F), or air dry (A). Effective DM degradability tended to be greater for HF compared with F ($P = 0.07$) and H ($P = 0.06$) and was greater than A ($P = 0.03$) and FF ($P = 0.05$). The rapidly and potentially degradable fractions and the degradation rate of DM were not different among treatments. Effective degradability of butyrate averaged 88.6% across all treatments and was not different between treatments. There were no differences in the butyrate degradation rate or the rapidly or potentially degradable fractions of butyrate. Results demonstrated that method of drying in situ residue from CB did not affect butyrate disappearance.

Key Words: butyrate, in situ methods

325P Effect of supplemental fat source on total-tract nutrient digestibility. P. L. Redding*, C. L. Wright, and A. E. Wertz-Lutz, *South Dakota State University, Brookings.*

An experiment was conducted to determine the effect of supplemental fat from either dried distillers grains plus soluble or raw corn oil on total tract nutrient digestibility in growing lambs. Six ruminally cannulated crossbred wethers (initial BW 55.8 ± 8.0 kg) were used in a 3 × 3 replicated Latin Square to determine the effect of supplemental fat source on total tract digestibility. Wethers were fed diets comprised of 10% grass hay and 90% of a pelleted feed comprised of 60.8% corn stover, 1.6% supplement, and one of the following treatment combinations: 1) 13% corn bran and 24.6% high-protein distillers grains (CON), 2) 10.4% corn bran, 24.9% high-protein distillers grains, and 2.4% raw corn oil (OIL), or 3) 37.6% dried distillers grains plus soluble (DDGS). All treatment diets were formulated to be isonitrogenous and the OIL and DDGS treatment diets were formulated to be iso-lipid. Lambs were adapted to treatment diets over a 16-d period where they received ad libitum access to feed and water. Daily feed intake and refusals were weighed and recorded to facilitate calculation of 90% ad libitum intake during the collection period. Wethers were then moved to metabolism crates for a 5-d collection period where they were fed at 90% ad libitum intake and had ad libitum access to water. Dry matter (DM), OM, NDF, ADF, and N intakes were lower ($P < 0.03$, 0.02, 0.01, 0.02, and 0.01, respectively) for wethers fed the DDGS and the OIL diets than wethers fed the CON diet. Intakes were not different between the DDGS and OIL treatments. There were no effects of treatment on DM, OM, NDF, ADF, or N digestibility ($P = 0.24$, 0.22, 0.15, 0.15, and 0.08, respectively). In summary, source of fat had no effect on total-tract digestibility; however, addition of fat to the diet decreased intake.

Key Words: fat, lambs, digestibility, distillers grains

326P Effect of fiber source on ruminal mat consistency in diets for Nellore steers. R. S. Goulart*[1,2], L. G. Nussio[1], K. Hongyu[1], A. V. Pires[1], J. L. P. Daniel[1], K. C. Swanson[2], and C. R. Dahlen[2], *[1]University of Sao Paulo/ESALQ, Piracicaba, SP, Brazil, [2]Department of Animal Sciences, North Dakota State University, Fargo.*

Six ruminally fistulated Nellore steers were used in a 6 × 6 Latin square to investigate the effects of fiber source on ruminal mat consistency. The 6 diets were composed of fiber sources: negative control (NC) with 10% NDF from corn silage (50.2% NDF, DM basis) and positive control (PC) with 20% NDF from corn silage; and 4 diets containing 10% NDF from corn silage and 10% NDF added from each of the following sources: sugarcane (SC; 46.8% NDF), sugarcane bagasse (SCB; 81.0% NDF), soybean hulls (SH; 75.1% NDF), and low oil cottonseed meal (LOCM; 49.2% NDF). Steers were housed in tie stalls and fed once daily at 0800 h for ad libitum intake. The effect of different fiber sources on ruminal mat consistency was measured at 4 h post feeding with the device described by Welch (1982) and data were analyzed using the Mixed procedure of SAS. Ruminal mat consistency was influenced ($P < 0.05$) by level and source of fiber. Rate of rise (cm/min) in steers fed SCB, SC, and LOCM was greater ($P < 0.05$) than in steers fed NC and SH. Additionally, overall chewing time in min/d was greater ($P < 0.05$) for steers fed PC (631 ± 18.7), SCB (648 ± 18.9), SC (634 ± 18.7), and LOCM (576 ± 18.7) compared with steers fed NC (427 ± 18.7) and SH (428 ± 18.9). In conclusion, feeding diets containing 20% NDF with half of the NDF coming from corn silage and half of the NDF coming from soybean hulls resulted in a ruminal mat consistency and chewing time equal to that of a diet containing only 10% NDF from corn silage. However, sugarcane bagasse, sugarcane and low oil cottonseed meal created a rumen mat of similar consistency to that created with diets including 20% NDF from corn silage.

Table 1. Ruminal mat consistency and effect on weight ascension time through the rumen

	Treatment						
Item	NC	PC	SCB	SC	SH	LOCM	SE
Total ascension, min	6.65^{d}	25.3^{bc}	31.6^{ab}	34.3^{a}	7.5^{d}	17.4^{c}	2.33
Distance traveled, cm	56.25^{a}	51.66^{ab}	42.45^{b}	43.50^{b}	54.40^{a}	47.01^{ab}	2.52
Overall rate, cm/min	8.51^{a}	2.07^{b}	1.34^{a}	1.33^{b}	7.76^{a}	2.81^{b}	0.36

^{abcd}Means lacking common supercripts differ ($P < 0.05$).

[1]NC = negative control; PC = positive control; SCB = sugarcane bagasse; SC = sugarcane; SH = soybean hulls; LOCM = low oil cottonseed meal.

Key Words: byproducts, chewing time, sugarcane

327P Adjusted intake based on forage particle length of forage and nonforage fiber sources in diets for Nellore Steers. R. S. Goulart*[1,2], L. G. Nussio[1], K. Hongyu[1], A. V. Pires[1], R. C. Amaral[1], K. C. Swanson[2], and C. R. Dahlen[2], *[1]University of Sao Paulo/ESALQ, Piracicaba, SP, Brazil, [2]Department of Animal Sciences, North Dakota State University, Fargo.*

Six ruminally fistulated Nellore steers were used in a 6 × 6 Latin square to investigate the effects of NDF intake and particle length on chewing time. The 6 diets were composed of fiber sources: negative control (NC) with 10% NDF from corn silage (50.2% NDF, DM basis), positive control (PC) with 20% NDF from corn silage, and 4 diets containing 10% NDF from corn silage and 10% NDF from 2 different sources of forage: sugarcane (SC; 46.8% NDF) and sugarcane bagasse (SCB; 81.0% NDF), and nonforage fiber sources (NFFS): soybean hulls (SH; 75.1% NDF) and low oil cottonseed meal (LOCM; 49.2% NDF). Steers were housed in tie stalls and fed once daily at 0800 h to achieve ad libitum intake. Intake of NDF was multiplied by mean particle length to obtain intake adjusted (kg.cm) for particle length. With the exception SCB, there were no differences ($P > 0.05$) in forage intake and total chewing time when diets were formulated with the same concentration of forage NDF in the TMR. Mean particle length of forage and NFFS differed ($P < 0.05$). In addition, the SH diets produced the lowest ($P < 0.05$) adjusted intake of byproduct sources and did not fit the polynomial curve. When SH data were removed, the effect of adjusted forage intake on total chewing time was quadratic, $y = 1128.85 - 457.41+57.73x^2$, r2 = 0.93. These data are useful to describe the relationship among intake based on forage particle length and total chewing time. Theoretically, the vertex of this equation suggests an adjusted intake of 3.96 (kg.cm) and predicts a minimum chewing time of 222.85 min.

Table 1. Intake characteristics in steers fed forage and non-forage fiber sources

	Treatment[1]						
Item	NC	PC	SCB	SC	SH	LOCM	SE
NDF Intake, kg·d^{-1}	0.80^{c}	1.84^{a}	1.36^{b}	1.71^{a}	1.76^{a}	1.90^{a}	0.06
Mean forage particle length, cm	1.93^{a}	1.91^{a}	1.93^{a}	1.95^{a}	0.64^{c}	1.56^{b}	0.73
Total chewing time, min·kg^{-1}·NDFf	582.6^{a}	252.0^{c}	381.7^{b}	268.5^{c}	258.0^{c}	242.5^{c}	15.6
Adjusted intake, kg.cm	1.52^{c}	3.51^{a}	2.62^{b}	3.33^{a}	1.13^{c}	2.96^{ab}	0.11

^{abc}Means lacking common superscripts differ ($P < 0.05$).

[1]NC = negative control; PC = positive control; SCB = sugarcane bagasse; SC = sugarcane; SH = soybean hulls; LOCM = low oil cottonseed meal.

Key Words: byproducts, forage, sugarcane

328P Ruminal degradable sulfur and ADG in beef cattle finishing diets. J. O. Sarturi*, G. E. Erickson, and T. J. Klopfenstein, *University of Nebraska, Lincoln.*

The relationships between ADG and estimated ruminal degradable S intake (eRDSI), measured (mRDSI), or total sulfur intake (TSI) were evaluated in beef cattle finishing diets. Ingredient samples and ADG data set from a previous growth performance experiment with steers (n = 120, BW = 345 ± 34kg), assigned to 1 of 13 treatments in a RCBD (9 steers/diet, except 12 steers for control) and fed for 151 d were used. Cattle were fed ad libitum once daily using Calan individual bunks. Treatments were designed with 3 distillers grains plus solubles (DGS) inclusions (20, 30, and 40% DM basis), fed either wet or dry that consisted of low (0.82%) or high (1.16%) S concentration in DGS, as well as a control diet, as a 3x2x2+1 treatment design. To calculate eRDSI, S degradability coefficients for the ingredients in the diet were predicted assuming that S follows the UIP kinetics, and all extra S added in the ethanol industry is readily available for ruminal reduction. For mRDSI, S degradability coefficients were measured in an IVDMD procedure, presented by the same authors (2011 ASAS Joint Annual Meeting), differing only on ruminal fluid donor (steers [n = 2; BW = 600 kg] fed 60% corn base diets) and replication (quadruplicate). Linear regressions in SAS were developed to evaluate the relationship between ADG and the parameters proposed. Using the entire data set, there were no effects among ADG and TSI ($P = 0.93$), eRDSI ($P = 0.44$) or mRDSI ($P = 0.74$). Since ADG was only impacted by steers fed high S wet DGS, only wet diets were analyzed. No relationship was observed between TSI and ADG ($P = 0.17$), whereas there was for eRDSI ($P = 0.04$) and a tendency for mRDSI ($P = 0.09$). Therefore, eRDSI (g/d) was able to explain 6% of the variation in ADG through a linear relationship (y = 1.93 - 0.00881 * eRDSI). Estimated S degradability coefficients using UIP values to adjust TSI to RDSI is a valuable tool to predict negative effects of S excess on ADG in wet high S DGS diets. In vitro measurement of S degradability coefficients is also a valuable tool compared with using only total S intake.

Key Words: ruminal degradable sulfur, co-products

329P Effects of cinnamon oil, tea tree oil, eucalyptus oil, anise oil, and cedar wood oil on rumen fermentation and biohydrogenation in batch cultures. A. Ishlak*[1], M. Gunal[2], and A. AbuGhazaleh[1], *[1]Southern Illinois University, Carbondale, [2]Süleyman Demirel University, Turkey.*

The objectives of this study were to explore the effects of adding essential oils (EO) at different levels (125, 250, 500 mg/L) on rumen fermentation and biohydrogenation. Treatments were control (CON), control plus cinnamon oil (CNO), control plus tea tree oil (TEO), control plus eucalyptus oil (EUO), control plus anise oil (ANO) and control plus cedar wood oil (CWO). Treatments were evaluated using in vitro 24-h batch culture of rumen fluid with 55:45 forage: concentrate dairy ration. All EO were dissolved in ethanol and a total of l ml was added to the culture fluid. Controls were also dosed with the same amount of ethanol. The incubation was conducted in 125 mL conical flask containing 40 mL buffer solution, 2 mL reduction solution, 10 mL of rumen fluid, 25 mg corn oil and 0.5 g of the diet. Samples were collected from cultures after 24 h and analyzed for ammonia-N, volatile fatty acids (VFA) and fatty acids. EO had no effects ($P > 0.05$) on the proportions of acetate, propionate and acetate to propionate ratios or ammonia-N concentrations. Addition of TEO, CNO and CWO, however, caused significant reductions ($P < 0.10$) in total VFA concentrations regardless of dose level. Compared with the CON, EO addition caused reductions ($P < 0.10$) in the concentrations of C18:0 and trans C18:1 with the reduction in C18:0 being dose-dependent particularly for CNO, CWO and EUO. Relative to CON, the concentration of linoleic acid (C18:2) was higher ($P < 0.05$) when ANO, TEO and CWO were added at 500 mg/L. Results from this study show that EO tested in this study had no effects on VFA profile or ammonia-N concentrations but significantly reduced the formation of biohydrogenation products (C18:0 and trans C18:1).

Key Words: essential oil, rumen, fermentation, biohydrogenation

Undergraduate Student Poster Competition

330P Effectiveness of pregnancy-specific protein B in pregnancy diagnosis of dairy cows and heifers. H. E. Arnold*[1], J. P. N. Martins[1], L. Z. Oliveira[2], R. K. Policelli[1], K. M. Stomack[1], C. Kostesich[1], R. G. Sasser[3], and J. R. Pursley[1], *[1]Michigan State University, East Lansing, [2]São Paulo State University (UNESP), Jaboticabal, SP, Brazil, [3]BioTracking LLC, Moscow, ID.*

The objective of this undergraduate research project was to evaluate the difference of pregnancy-specific protein B (PSPB) levels in early pregnancy diagnosis of lactating dairy cows (n = 56) vs. heifers (n = 23). Lactating dairy cows between 71 and 271 DIM at time of first blood collection were used. Blood samples were collected daily from d 15 to d 35 after estimated fertilization to assess serum PSPB. PSPB levels were determined using the BioPRYN ELISA assay (BioTracking LLC, Moscow, ID), measured by optical density (OD). Pregnancy diagnosis using transrectal ultrasonography was conducted on d 22 (n = 39), d 29 (n = 68) and d 36 (n = 79) after d of AI to determine embryo presence and viability. Average daily PSPB in circulation between d 15 to d 35 after estimated fertilization was greater ($P < 0.001$) in non-pregnant lactating dairy cows (n = 34; 0.099 ± 0.001 OD) than for non-pregnant heifers (n = 8; 0.080 ± 0.001 OD). Serum PSPB of pregnant cows were greater ($P < 0.01$) than non-pregnant cows beginning on d 23 after AI. However, serum PSPB levels of pregnant heifers were greater ($P < 0.02$) than non-pregnant heifers beginning on d 20 after AI. A 50% increase from serum PSPB basal levels was detected earlier ($P < 0.001$) in pregnant heifers compared with pregnant cows (23.3 ± 0.33 vs. 26.3 ± 0.38 d). Pregnant cows had greater ($P < 0.05$) serum levels of PSPB between d 15 to d 19, similar PSPB levels between d 20 and d 22, lower ($P < 0.03$) PSPB levels from d 23 to d 28, and similar between d 29 and d 35 post fertilization compared with pregnant heifers. A 100% sensitivity and 100% negative predictive value were observed earlier in heifers (d 23) than in cows (d 29). When cows with embryonic loss (n = 4) were excluded from the analysis, 100% specificity and 100% positive predictive value were detected earlier in heifers (d 24) than in cows (d 31). These data indicate that serum PSPB can be used as a pregnancy diagnosis test earlier in dairy heifers than in lactating dairy cows.

Key Words: pregnancy-specific protein B (PSPB), pregnancy diagnosis, lactating dairy cows, dairy heifers

331P Effects of supplemented dried distillers grains versus corn on internal parasites and performance in growing beef heifers. L. R. Welker*, T. L. Felix, F. A. Ireland, and D. B. Faulkner, *University of Illinois, Urbana.*

Grain supplementation to lambs on pasture can reduce parasite load and improve performance. Furthermore, supplementing dried distillers grains with solubles (DDGS) has been shown to reduce parasite load when compared with supplemental corn in grazing lambs. Little is known about the effect of DDGS on performance and parasite load in grazing cattle. Therefore, the objective of this study was to determine if DDGS supplementation to grazing heifers would reduce parasite load and improve performance compared with corn supplementation. Heifers (n = 160; BW = 276 ± 24 kg) were split into 4 treatment groups with 4 replicates per treatment. Heifers were randomly assigned to treatment and replicate. The 4 replicates were stratified across 16 paddocks (2.02 ha) of tall fescue. Treatments were 1) 1.36 kg corn/hd/d, 2) 2.73 kg corn/hd/d, 3) 1.36 kg DDGS/hd/d, and 4) 2.73 kg DDGS/hd/d. There were no treatment interactions ($P > 0.12$); therefore, main effects of source and level of supplement are presented. Heifers fed DDGS had greater ($P < 0.01$) packed cell volume (PCV) than heifers fed corn. Furthermore, heifers that received 2.73 kg/hd/d of supplement had greater ($P < 0.01$) PCV than heifers that received 1.36 kg/hd/d of supplement. There were no differences ($P > 0.05$) between source or level of supplement for fecal egg count. However, over time, fecal egg counts increased ($P < 0.05$) regardless of treatment. Heifers fed 2.73 kg of supplement/hd/day had 0.405 kg/d greater ($P < 0.01$) ADG than heifers fed 1.36 kg of supplement/hd/d. Heifers fed DDGS had 0.195kg/d greater ($P < 0.01$) ADG than heifers fed corn. This response in ADG caused heifers fed 2.73 kg of supplement/hd/d to have 32.5 kg greater ($P < 0.01$) final BW than heifers fed 1.36 kg of supplement/hd/d of and heifers fed DDGS to have 18.5 kg greater ($P = 0.04$) final BW than heifers fed corn. Heifers supplemented with DDGS did not have reduced fecal egg counts when compared with those supplemented with corn. However, DDGS supplementation had a positive effect on overall heifer performance including ADG, final BW, and PCV versus corn supplementation.

Key Words: distillers grains, parasites, cattle

332P The effects of supplemental protein source on performance of calves fed tall fescue hay. N. F. Johnson*, M. S. Kerley, and W. J. Sexten, *University of Missouri, Columbia.*

Spring-born Red Angus sired calves (n = 100) were randomly assigned to one of 2 supplemental protein treatments to evaluate the effect of supplemental protein source on post-weaning performance. Calves were fed either distillers grains based unbalanced protein supplement (UBS) or a balanced protein supplement (BPS) formulated to provide equivalent protein and energy to the UBS beginning 15 October 2009. Protein supplements were offered at 1% of BW on a DM basis. Endophyte-free tall fescue hay (93.84% DM; 60.13% NDF; 38.17% ADF; 11.24% CP) was offered as large round bales. At conclusion of the 84 d backgrounding period calves were transitioned to a no-roughage corn-based diet. Performance data were analyzed as a randomized complete block design using the mixed procedures of SAS. Both UBS and BPS resulted in backgrounding average growth rate of 0.77 kg/day. The moderate growth rate observed during the backgrounding period was hypothesized as the reason no ADG differences ($P = 0.93$) were observed due to BPS. We concluded UBS in addition to microbial protein provided sufficient amino acids to calves to support 0.77 kg/day ADG. The energy provided by hay and protein supplement limited full utilization of amino acids provided by BPS. Calves fed BPS during the backgrounding period gained 0.09 kg/day more ($P = 0.04$) and tended to have improved ($P < 0.17$) feed to gain ratio during the finishing period. The BPS improved post-ruminal amino acid availability using SoyPlus (soybean meal). Backgrounding protein supplementation did not have an effect on carcass characteristics ($P > 0.05$). In this experiment when growing calves gained 0.77 kg/day during the backgrounding period increasing post-ruminal amino acid supply did not improve growing period performance, although subsequent feedlot performance was improved. Further research is necessary to validate effects beyond the backgrounding period and to determine if limited energy inhibits growth of calves during the growing period when BPS offered.

Key Words: backgrounding, supplementation, beef

333P Evaluation of *Rhizopus oligosporus* yeast supplementation on growth performance and nutrient digestibility in nursery pigs. D. M. van Sambeek*[1], T. E. Weber[2], B. J. Kerr[2], J. (Hans) van Leeuwen[1], and N. K. Gabler[1], *[1]Iowa State University, Ames, [2]USDA-ARS, Ames, IA.*

The thin stillage leftover from ethanol production contains biodegradable organic compounds and sufficient micronutrients that are ideal for fungal cultivation of *Rhizopus oligosporus* (RO). This fungus removes about 60% of the organic material, including the suspended solids and even more of some specific substances that are undesirable for recycling. The resulting fungal pellets can easily be harvested as a food-grade organism, which is rich in fat and amino acids, specifically lysine and methionine. Thus, this value-added byproduct may be a suitable feed ingredient for swine. We conducted a 4-wk growth performance experiment using 24 gilts (5.62 ± 0.35 kg BW) allocated to 1 of 3 diets: 0% RO, 10% RO or 20% RO (n = 8 pigs/trt). All diets were formulated to be isocaloric and contained the digestibility marker titanium dioxide. Pig feed intake and body weights were measured weekly, and total tract fecal samples were collected at wk 4. Irrespective of dietary treatment, there was no difference in pig ADFI (P = 0.97), ADG (P = 0.94) or G:F (P = 0.55) over the 4-wk nursery period. Proximate analysis of feed and fecal samples yielded the following apparent total-tract digestibility coefficients for 0% RO, 10% RO or 20% RO, respectively: Gross energy, 85.6, 86.7 and 81.1% (P < 0.001); P, 58.0, 59.2 and 46.5% (P < 0.01); and N, 86.2, 84.3 and 82.8 (P < 0.05). Total tract DE was improved feeding 10% RO (4.16 Mcal/kg), but not 20% RO (3.81 Mcal/kg) versus the control treatment (4.01 Mcal/kg). Altogether, these data indicate that *Rhizopus oligosporus* cultivated on distillers stillage and bioproducts can be used in nursery swine diets with no negative effects on performance. However, as the inclusion rates increase, nutrient digestibility may decrease.

Key Words: pig, *Rhizopus oligosporus*, growth performance, digestibility

334P Effect of bedding material on air quality of bedded manure packs in livestock facilities. S. J. Abatti*[1], M. J. Spiehs[1], T. M. Brown-Brandl[1], D. N. Miller[2], and D. B. Parker[1], *[1]USDA-ARS U.S. Meat Animal Research Center, Clay Center, NE, [2]USDA AgroEcosystems Management Research Unit, Lincoln, NE.*

Materials such as corn stover and wood chips are often used for bedding in livestock facilities. Bedding materials may affect air quality emissions from livestock facilities. The objective of this study was to determine how different bedding materials affect air quality. Beef manure from cattle fed a dry-rolled corn finishing diet was added to corn stover (CS), pine chips (PC), dry cedar chips (DCC), and green cedar chips (GCC) in lab-scaled bedded manure packs. Headspace concentrations were monitored for odorous volatile organic compounds (VOC), NH_3, CO_2, CH_4, and N_2O. Air samples were collected from the headspace of the bedded packs on d 0, 7, 14, 21, 28, 35, and 42 for NH_3, CO_2, CH_4, and N_2O analyses and on d 0, 21, and 42 for VOC analyses. Concentrations of CO_2 and N_2O were similar among bedding materials ($P \geq 0.17$). Concentrations of CO_2 and N_2O increased throughout the 42-d study (P < 0.01). Methane was similar for all treatments except for PC, which was higher than all other treatments on d 35. Ammonia was highest in packs containing PC and lowest in packs with DCC and GCC (P < 0.01). Ammonia concentrations increased for all bedding materials to d 28 and then began to decline (P < 0.01). Sulfur-containing and aromatic VOC were similar for the 2 cedar products ($P \geq 0.14$), but concentrations of both VOC were higher in packs containing DCC compared with PC or CS (P < 0.01). Results of this study indicate that use of cedar products as bedding material may decrease NH_3 concentration but will increase the concentration of odorous VOC compared with PC or CS.

Key Words: ammonia, bedding, greenhouse gas, odor

335P Effects of maternal dietary energy source during mid to late gestation on fetal organ and adipose tissue growth in sheep. E. J. Cretney*[1], J. S. Luther[2], M. A. Berg[1], R. L. Burgett[1], J. Susko-Parrish[1], R. R. Magness[1], and A. E. Radunz[1], *[1]University of Wisconsin-Madison, Madison, [2]University of Wisconsin-River Falls, River Falls.*

Multiparous Polypay ewes (n = 14) were individually penned to determine the effects of maternal dietary energy source during mid- to late-gestation on fetal organ and adipose tissue development. Ewes carrying singletons (n = 5) or twins (n = 9) were used in the analysis. From d 67 ± 3 of gestation until necropsy (d 130), ewes were fed 1 of 3 diets formulated to contain 3.52 Mcal ME/d with the major energy source from alfalfa haylage (HL), corn (CN), or dried corn distillers grains (DG). At necropsy, crown-rump length (CR), abdominal girth, thoracic girth, head length, and head width were measured, fetal body weight (BW) was determined and internal organs were removed and weighed. Contents of the gastrointestinal tract and mesenteric adipose tissue were removed before weighing. The semitendinosus and longissimus dorsi muscles were removed from the left side of the fetus and weighed. The remaining carcass was ground for future determination of fat, CP, and ash content. The PROC MIXED procedure of SAS was used to analyze the data; fetus sex and type of birth were included as covariates when significant ($P \leq 0.05$). Fetal body dimensions were not different ($P \geq 0.50$) among treatments. Fetal BW remained similar among HL, CN and DG maternal dietary energy sources (P = 0.70). Mass of all major fetal organs was not influenced ($P \geq 0.33$) by maternal dietary energy source, except the fetal adrenal gland. Male fetuses from CN dams had smaller ($P \leq 0.04$) adrenal glands (g/kg BW) than males and females from HL and DG dams. Furthermore, females from CN dams had larger adrenal glands (g/kg BW) when compared with males and females from HL and DG dams ($P \leq 0.03$). Total mass of internal adipose tissue (heart, mesenteric, and perirenal fat) remained similar (P = 0.36) among treatments, however, female fetuses from CN dams had greater ($P \leq 0.05$) perirenal fat than male fetuses from CN and DG dams, and female fetuses from HL dams (P = 0.05). Overall, maternal dietary energy source did not influence fetal body dimensions, BMI, PI, or fetal BW at necropsy, and the mass of most fetal organs and adipose tissue depots remained similar.

Key Words: fetal programming, maternal nutrition, adipose, sheep

336P The effects of added distillers grains and Fibrozyme to beef finishing diets on in vitro ruminal digestibility and fermentation kinetics. C. Kalkowski*[1,2], K. Mjoun[2], and J. Jennings[2], *[1]South Dakota State University, Brookings, [2]Alltech Inc., Brookings, SD.*

Digestibility and fermentation parameters were evaluated in finishing beef diets based on distillers dried grains with solubles (DDGS) using ruminal in vitro gas production techniques. In experiment 1, 12 sources of DDGS from the Midwest were evaluated. In experiment 2, the effects of 2 sources of DDGS (low and high digestibility; determined based on experiment 1), fed at 20–60% of diet DM, (replacing dry rolled corn), forage type (grass and alfalfa hays), and the addition of a fibrolytic enzyme (Fibrozyme, Alltech Inc.) at different doses (0, 1.5, and 3 mg/ml of inoculum) were evaluated. Fermenta-

tion curves were fitted to a 2 pool logistic model that estimates fast pool gas production corresponding to fermented sugars and starch, and a slow pool corresponding to fermentable fiber and their respective rates. In experiment 1, fast pool gas (77.0 to 117.1 mL/g OM), total gas (191.0 to 224.2 mL/g OM), methane production (9.59 to 11.99 mL/g OM), and pH (6.59 to 6.76) varied with DDGS sources. Apparent and true DM digestibilities (ADDM and TDDM), rates of degradation, and microbial biomass yield were not affected by the source of DDGS. In experiment 2, DDGS concentration had the most effect on fermentation parameters, whereas minimal effects were noted for DDGS source, forage type, and the addition of Fibrozyme. The inclusion of alfalfa hay resulted in shorter lag time (0.58 vs. 0.70 h) and higher TDDM (80.9 vs. 78.1%) compared with grass hay. The addition of Fibrozyme at 1.5 mg /ml of inoculum increased pH from 6.60 to 6.63 and reduced lag time from 0.75 to 0.53 h. Increasing DDGS from 20 to 60% resulted in a decrease in slow pool gas (145.3 to 126 mL/g OM), total gas production (232.3 to 210 mL/g OM), and TDDM (81.0 to 77.3%). Differences in the degradation rate corresponding to the fast pool and ADDM were observed but a consistent trend could not be determined. In vitro fermentation kinetics varied upon DDGS source and concentration, and the addition of Fibrozyme did not improve DM digestibility in beef finishing diets based on DDGS.

Key Words: distillers grains, fibrolytic enzyme, digestibility, in vitro system

337P Effect of high and low levels of urea in beef cattle finishing diets on shelf life stability of fresh ground beef. J. E. Johnston*, K. M. McClelland, I. Ceconi, G. I. Crawford, and R. B. Cox, *University of Minnesota, St. Paul.*

Crossbred steers (n = 42) were assigned randomly to one of 3 treatment groups and individually fed utilizing a Calan gate feeding system. Treatments were dry-rolled corn-based control with no supplemental urea (CON); CON with urea at 0.4% DM (LOW); CON with urea at 0.6% DM (HIGH). Cattle were humanely harvested at a commercial abattoir and shoulder clods were removed from the right side of each carcass, 48 h postmortem, vacuum packaged and transported to the University of Minnesota Meats Laboratory for further analysis. Shoulder clods were weighed before and after package removal to evaluate purge loss percentage and pH was recorded before grinding. Clods were ground twice through a 0.375 cm plate and 500 g of ground beef from each clod were placed in a polystyrene tray, overwrapped with PVC film and stored at 4°C under cool, white fluorescent lighting. Objective color (L*, a*, and b*) values were recorded for 6 consecutive days using a Minolta CR-310 colorimeter. For subjective evaluation, 6 trained panelists were asked to evaluate ground beef for lean color, surface discoloration, and overall appearance. Data were analyzed using the mixed procedure in SAS version 9.2 (SAS Institute, Cary, NC). Purge loss percentage and pH showed no difference ($P > 0.05$) between treatments. Objective color scores (L*, a*, and b*) showed no differences ($P = 0.71$, 0.09, 0.53, respectively). CON had lower values for lean color ($P < 0.001$), greater surface discoloration ($P = 0.005$), and lower overall appearance ($P = 0.001$) compared with LOW and HIGH. These results suggest that urea added to the diet has no effect on objective color scores, purge loss, and pH but may affect subjective evaluation of ground beef in retail display.

Key Words: color score, urea, ground beef

338P Utilization of two dimensional-differential in-gel electrophoresis (2D-DIGE) to evaluate the proteomic profile during oocyte maturation in pigs. J. T. Seibert*, E. C. Wright, C. X. Yang, S. M. Lonergan, and J. W. Ross, *Iowa State University, Ames.*

During maturation the oocyte undergoes dynamic changes as it progresses from prophase I of meiosis until metaphase II arrest. The first physical sign that an oocyte is committed to maturation is the breakdown of the germinal vesicle (GV). Following GV breakdown, transcriptional activity is minimal until the activation of the embryonic genome at the 4-cell stage of development. Our working hypothesis is that despite the lack of transcriptional activity in the oocyte following GV breakdown, global changes in protein expression in the oocyte during meiotic progression is in part regulated by miRNA expression. The objective of this project is to determine differential protein expression during oocyte maturation in pigs. Differential protein expression between these 2 stages of oocyte development can be effectively demonstrated with the use of two dimensional-differential in-gel electrophoresis. Sow ovaries were obtained from a local abattoir and cumulus-oocyte complexes (COC) were aspirated from 3 to 6-mm follicles. Cumulus cells and oocytes were separated in germinal vesicle stage (GV) COC and 4 replications (400 oocytes per rep) were snap-frozen in liquid nitrogen. Remaining oocytes (approximately 600) from each replication were in vitro matured. After 42–44 h in vitro maturation, cumulus cells were removed and MII arrested oocytes (4 replications of 400 MII oocytes) were collected. Oocytes for each stage and replication were lysed and protein contents were labeled with Cy5 dye; a reference pooled protein sampled was labeled with Cy3 dye. Following resolution on 2 D gels, gels were imaged and DeCyder software (GE Healthcare) was used to identify protein spots that were statistically different between GV and MII arrested oocytes. In total, 284 protein spots were identified of which 14 were significantly greater in GV stage oocytes and 19 were more abundant in MII oocytes. These data demonstrate the effective use of 2D-DIGE for global proteomic analysis in pig oocytes during meiotic progression.

Key Words: oocyte, gamete, proteomics, pig

339P Impact of initiation of standing estrus at time of controlled internal drug releasing device insertion on fertility in beef heifers. O. L. Swanson*, J. K. Grant, K. L. Gebhart, L. K. Kill, and G. A. Perry, *Department of Animal Science, South Dakota State University, Brookings.*

Ovulatory response at the start of a fixed-time AI protocol has been reported to influence pregnancy success. An injection of PG 3 d before an injection of GnRH increased ovulatory response; however, some heifers exhibit estrus before the injection of GnRH. Therefore, the objective of this study was to determine if estrus before the injection of GnRH at the start of a fixed-time AI protocol affected pregnancy success. Heifers (n = 292) were synchronized with an injection of PG (25 mg) on d −9, an injection of GnRH (100 μg) and insertion of CIDR on d −6, and an injection of PG and CIDR removed on d 0. Blood samples were collected on d −9 and −6 for determination of serum concentrations of progesterone. EstroTect estrus detection patches were placed on each heifer on d −9. At time of CIDR insertion, patches were classified as completely activated, partially activated, or not activated. All activated and partially activated patches were replaced at CIDR removal, and standing estrus was determined by patch activation at time of fixed-time AI, 60 to 66 h after CIDR removal. Pregnancy success was determined 32 d after AI. Heifers with activated patches at time of CIDR insertion tended to have increased pregnancy success

compared with heifers with patches that were partially activated ($P = 0.10$) or not activated ($P = 0.06$). In addition, heifers with activated patches at time of fixed-time AI had greater pregnancy success compared with heifers with patches partially activated ($P = 0.03$) or not activated ($P < 0.01$). Pregnancy success among heifers with partially and not activated patches was similar ($P = 0.57$). In summary, heifers that exhibited estrus before an injection of GnRH tended to have higher pregnancy rates than heifers that did not, and heifers that exhibited estrus at time of fixed-time AI had higher pregnancy rates than heifers that did not.

Key Words: estrus, fixed-time AI, pregnancy success

340P Effect of heifer calving date on longevity and lifetime productivity. L. K. Kill*[1], E. M. Mousel[1], R. A. Cushman[2], and G. A. Perry[1], *[1]Department of Animal Science, South Dakota State University, Brookings, [2]U.S. Meat Animal Research Center, Clay Center, NE.*

Longevity and lifetime productivity are important factors influencing profitability. Heifers that conceive earlier in the breeding season will calve earlier in the calving season and have a longer interval to rebreeding. Calves born earlier in the calving season will also be older and heavier at weaning. Longevity data were collected on 2,195 heifers from producers in South Dakota Integrated Resource Management groups. Longevity and weaning weight (ww) data were collected on 16,549 individual heifers at the USMARC. Data were limited to heifers that conceived during their first breeding season. Heifers were grouped into 21-d calving groups. Heifers were determined to have left the herd when they were diagnosed not pregnant at the end of the breeding season. Heifers that left the herd for reasons other than reproductive failure were censored from the data. Heifers that calved with their first calf during the first 21-d period of the calving season had increased ($P < 0.01$) longevity compared with heifers that calved in the second 21-d period, or later. Average longevity for South Dakota heifers that calved in the first or later period was 5.1 ± 0.1 and 3.9 ± 0.1 yr, respectively. Average longevity for USMARC heifers that calved in the first, second, and later period was 8.2 ± 0.3, 7.6 ± 0.5, and 7.2 ± 0.1 yr, respectively. Calving period influenced ($P \leq 0.03$) ww of the 1st, 2nd, 3rd, 4th, and 5th calf; but did not influence the ww of the 6th ($P = 0.24$), 7th ($P = 0.30$), 8th ($P = 0.30$), and 9th ($P = 0.37$) calf. In addition, calving period influenced total pounds weaned and mean ww ($P < 0.01$), with heifers that calved during the first period having increased ww, total pounds weaned, and mean ww compared with heifers calving in the second or later period, and heifers calving during the second period having increased ww, total pounds weaned, and mean ww compared with heifers calving later. In summary, heifers that calved early in the calving season with their first calf had increased longevity and pounds weaned compared with heifers that calved later in the calving season.

Key Words: calving, heifers, longevity

341P Weekly exercise does not influence performance but impacts handling of feedlot cattle. G. C. Buus*[1], M. Loewe[2], and B. P. Holland[1], *[1]South Dakota State University, Brookings, [2]Opportunities Farm, Lennox, SD.*

Three hundred 80 7 crossbred steers (initial BW = 420 kg) were allotted by chute order at processing to one of 5 pens (77 or 78 steers per pen), and pens were assigned to one of 2 exercise programs: control (CON; n = 2 pens) or exercise (EX; n = 3 pens). Cattle in the exercise treatment were removed from their pens (25.5 or 20.0 m^2/animal) by one handler into a drover's alley (3.6 m wide) 108 to 181 m in length. Steers were allowed to loiter for 5 min before being returned to their home pens. Exercise was conducted one d per week at approximately 0800 h. Control cattle remained in their home pens for the duration of the feeding period except for normal management procedures such as disease treatment. All animal handling procedures were conducted with minimal or no use of sounds, whips, or other forceful measures. Cattle remained on feed for 125 to 129 d before slaughter. On the morning of shipment, cattle were removed from each pen, weighed in groups of 15–20 on a platform scale, and loaded into trailers. During exercise and final loading, pens were scored based on temperament and handling ease (1–5), where 1 = no difficulty and 5 = extreme difficulty. In addition, time required for weekly exercise and loading was recorded. No differences ($P > 0.10$) were observed in feedlot performance or carcass characteristics including ADG, DMI, HCW, fat thickness, marbling score, or USDA Yield and Quality grades. Over the course of the feeding period, exercise duration ranged from 12 to 25 min per pen. Week on feed was negatively ($P < 0.006$), and total time taken for exercise was positively ($P < 0.001$) correlated with handling score. More time ($P = 0.06$) was required to weigh exercise pens than control (17.5 vs. 26.7), although total time taken to weigh and load trucks (43.0 vs. 52.3 min) was not different ($P = 0.11$). When real labor costs were applied to exercise treatment, net returns were less ($P = 0.03$) for EX, than CON pens. Although performance was not affected, handling and economic factors should be considered when developing exercise regimens for feedlot cattle.

Key Words: feedlot, handling, exercise, cattle

342P Quick test for sulfur level in ethanol co-products. L. J. Daniels*, M. E. Drewnoski, and S. L. Hansen, *Iowa State University, Ames.*

Sulfur (S) is the main limiting factor in the amount of ethanol co-products used in ruminant diets. Sulfuric acid is used in the ethanol production process and results in ethanol co-products having variable and often high S content. The unknown amount of S in co-products increases the risk of S toxicity when co-products are being included at high levels in the diet. Therefore, a study was conducted to determine whether it is possible to predict the S content by measuring the pH of the ethanol co-product. Samples of corn co-products from the dry milling process including dried distillers grains plus solubles (n = 12), modified distillers grains (n = 11), wet distillers grains (n = 9), and condensed distillers solubles (CDS; n = 8), were collected from 4, 1, 5, and 3 different ethanol plants, respectively. Samples of wet corn gluten feed (WGF) were collected from 2 wet milling plants (n = 13). All the samples except for the CDS were made into 20% solutions before their pH was measured, whereas the pH of CDS was measured without dilution. Samples were dried at 70°C for at least 48 h to determine DM and then ground in a Wiley Mill. All the samples, including the CDS, were microwave digested and % S was determined using an ICP-OES. Regression analysis was carried out using PROC REG in SAS. There was no distinction among the types of distillers grains in their relationship between % S on a DM basis and pH; therefore, data for distillers grains were pooled. Samples of distillers grains ranged from 0.50 to 1.09% S with a pH of 3.54 to 4.86. Wet gluten samples had S ranging from 0.38 to 0.52% S with a pH range of 4.05 to 4.37. Samples of CDS ranged from 0.80 to 1.48% S with a pH of 3.62 to 4.76. There was a strong correlation between pH and % S for distillers grains ($R^2 = 0.87$;$P < 0.01$), WGF ($R^2 = 0.59$; $P < 0.01$) and CDS ($R^2 = 0.98$; $P < 0.01$). This simple pH test could be used by producers to predict the level of S in new loads of co-products as they arrive at the

farm, potentially allowing producers to safely maximize co-product inclusion in the diet while minimizing risk of S toxicity.

Key Words: distillers grains, pH, sulfur

343P Effects of dietary sulfur source on ruminal pH and hydrogen sulfide of feedlot steers. C. J. Brasche*, M. E. Drewnoski, and S. L. Hansen, *Iowa State University, Ames.*

Many universities have conducted research trials on the effects of dietary sulfur (S) on the potential for toxicity in cattle; however, different sources of dietary S have been used. The objective of this experiment was to compare the effects of 5 commonly used S sources: dry distillers grains with solubles (DDGS), condensed distillers solubles (CCDS), sulfuric acid, sodium sulfate, and calcium sulfate on ruminal pH and hydrogen sulfide (H_2S) concentrations. Fistulated steers were used in a 5 × 5 Latin square and were limit fed at 1.3% BW. All diets contained 45% corn, 10% chopped hay, and 21% DDGS and 0.5% S on a DM basis. The S source was added to the diet to contribute 0.19% S and soyhulls were added to make up the balance of the diet. Water was added to the non-CCDS diets to equalize moisture across diets at 69% DM. Diet pH ($P < 0.01$) and ruminal pH ($P < 0.01$) differed among S sources. However, there was no difference ($P = 0.6$) among S sources in ruminal H_2S (3060 ± 880 ppm) measured 6 h post–feeding. These data suggest that there is no difference in the potential for S toxicity among the different S sources used in this study.

Table 1. Effect of dietary sulfur source on pH of the diet and ruminal pH

Item	DDGS	CCDS	Sulfuric acid	Sodium sulfate	Calcium sulfate	SEM	*P*-value
pH of diet	4.08^{c}	4.18^{b}	3.93^{d}	4.79^{a}	4.79^{a}	0.03	<0.01
Minimum ruminal pH	5.02^{c}	5.24^{a}	4.97^{cd}	5.13^{b}	4.89^{d}	0.08	<0.01
Maximum ruminal pH	6.02^{c}	6.25^{b}	6.42^{a}	6.20^{b}	6.10^{bc}	0.11	<0.01
Change in ruminal pH	1.20^{c}	1.22^{c}	1.58^{a}	1.35^{b}	1.40^{b}	0.07	<0.01
Ruminal pH at H_2S sampling	5.40^{a}	5.51^{a}	5.28^{b}	5.43^{a}	5.03^{c}	0.07	<0.01

$^{a-d}$Means lacking common superscripts within row differ ($P < 0.05$).

Key Words: cattle, sulfur, toxicity

AUTHOR INDEX

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