



abstracts

March 14–16, 2011

Des Moines, Iowa

Please do not cite this program as the definitive source of abstracts contained herein. The ADSA abstracts will appear in the *Journal of Dairy Science*[®] (Vol. 94 and posted at <http://www.adsa.org/meetingabs.asp>); the ASAS abstracts will be posted online at http://jas.fass.org/misc/abstr_proc.shtml as part of the 2011 Section Meeting Abstracts (Vol. 89, E-Suppl. 2) of *Journal of Animal Science*.

Table of Contents

Section	Abstract Numbers	Page Number
Animal Behavior, Housing, and Well-Being	1–18.....	1
Billy N. Day Symposium: The Replacement Gilt.....	19–24.....	8
Breeding and Genetics	25–44.....	10
David H. Baker Symposium: Amino Acid Symposium.....	45–51.....	18
Extension—Beef/Small Ruminant Symposium.....	52–60.....	21
Extension—Dairy	61–72.....	25
Extension—Swine.....	73–80.....	29
Graduate Student Oral Competition—M.S.....	81–100.....	32
Graduate Student Oral Competition—Ph.D.	101–116.....	38
Graduate Student Poster Competition—M.S.....	117–124.....	44
Graduate Student Poster Competition—Ph.D.....	125–132.....	46
Graduate Student Symposium: Tips on How to Navigate the Job Search and Interview Process for Animal Science Students.....	133–135.....	50
Growth, Development, Muscle Biology, and Meat Science	136–150.....	51
Nonruminant Nutrition.....	56, 151–267.....	57
Odor and Nutrient Management	268.....	98
Physiology.....	269–290.....	98
Ruminant Nutrition	291–336.....	107
Teaching.....	337–339.....	123
Undergraduate Student Oral Competition.....	340–353.....	125
Undergraduate Student Poster Competition.....	354–358.....	130
Author Index		132

ADSA-ASAS Midwest Meeting

Monday, March 14, 2011

SYMPOSIA AND ORAL SESSIONS

Animal Behavior, Housing, and Well-Being: Animal Pain— The Science and the Issues

1 (Invited) Animal pain, animal welfare and animal production - what's on the horizon? S. Millman,* *Iowa State University, Ames.*

Animal pain is a key component of animal welfare and is often at the heart of concerns raised about particular husbandry practices. Regional differences exist in terms of which husbandry practices are criticized, as well as the manner in which these concerns are addressed by animal producers, veterinarians, industries, retailers and policy makers. Pain is defined by the International Association for the Study of Pain as “an unpleasant sensory and emotional experience associated with actual or potential tissue damage.” For both humans and animals, affective states such as pain can only be measured indirectly. Novel and emerging techniques in the laboratory are facilitating scientific scrutiny of animal pain and evaluation of interventions. In the field, recognition of species-specific and insult-specific responses to pain is necessary for timely diagnosis of ill and injured individuals within the herd. Understanding animal responses to pain and distress are central to effective management of convalescent livestock and decision-making about euthanasia.

Key Words: animal welfare, animal behavior, pain, lameness public attitudes

2 (Invited) Physiological, behavioral and neurological approaches to studying pain in cattle. L. N. Edwards*¹, J. F. Coetzee², and L. Bergamasco², ¹*Kansas State University, Department of Animal Science and Industry, Manhattan*, ²*Kansas State University, College of Veterinary Medicine, Manhattan.*

There is an ever-growing concern in society for farm animal welfare with one current area of focus being pain control during routine husbandry practices such as castration and dehorning. To improve pain management in livestock, it is necessary to understand, identify and objectively measure pain responses in animals; a difficult task. Traditionally, stress hormones such as cortisol have been used to assess pain

in many species. Although cortisol can provide insight into the physiological effects of a potentially stressful and painful event, cortisol is also impacted significantly by restraint and handling thus potentially confounding the interpretation. Other physiological measurements, such as plasma substance P, heart rate, respiration rate and changes in sympathetic tone and vascular perfusion, detected by thermography, are also used to assess pain responses in livestock. Changes in an animal's activity level and behavior are commonly used to assess pain. Behavioral measures, which can be captured and quantified without the confounding presence of humans using remote sensors, offer the most promising measures of pain and distress. Since the cerebral cortex is significant to an animal's perception of pain, there has been recent work performed using the electroencephalogram (EEG) as an indicator of pain in livestock species. Research has been conducted to characterize the bovine EEG response during castration without analgesia and simultaneously correlate the EEG response with other physiological and behavioral measurements providing a comprehensive description of the pain response in cattle. Physiological, behavioral and neurophysiological approaches to studying pain should be used concurrently to provide a complete pain model in farm animals thus enabling producers and veterinarians to develop optimal and appropriate pain management protocols.

Key Words: behavior, cortisol, EEG, pain

3 (Invited) Behavioral approaches to pain assessment in beef cattle. K. S. Schwartzkopf-Genswein,* *Agriculture and Agri-Food Canada, Lethbridge, AB, Canada.*

Ruminants are a prey species evolved to be stoic in their exhibition of pain so predators would be less likely to use overt cues to target injured or weak individuals. As a consequence, behavioral assessments of acute and chronic pain in cattle are more problematic than in other species. Nonetheless, behavioral assessments of pain have been used by the veterinary and animal science professions since their inception.

These assessments typically involve visual appraisals of an animal's posture, movement, vigor and motivation to feed. Although skilled animal care givers can use these visual cues to identify animals requiring medical attention, behavioral assessments have often been criticized because of their subjective nature which makes them prone to error and misinterpretation. Current technology such as RFID, GPS, image analysis, accelerometers and strain gauge instrumentation allow for the quantification of cattle behavior previously unattainable by visual assessment alone. Electronic documentation of individual animal responses to pain, including stimuli specific or daily movements and individual feed and water intake, have been used successfully to identify the onset, magnitude and duration of pain associated with various routine management procedures used in cattle. For example, using image analysis, hot iron-branded steers were found to have greater ($P < 0.05$) maximum and average head movement distances and velocities than freeze branded or control steers, while freeze steers only had greater ($P < 0.05$) maximum values than controls. Substantial research is still required to determine the relationship between behavioral and physiological indicators of pain. In addition, the continued development of novel, quantifiable methods of pain assessment using behavior is essential to further our understanding for identification and mitigation purposes.

Key Words: cattle, pain assessment, behavior

4 (Invited) Surgical procedures in swine. T. M. Widowski^{*1}, K. Bovey¹, and S. Torrey², ¹University of Guelph, Guelph, ON, Canada, ²Agriculture and Agri-Food Canada, Guelph, ON, Canada.

Pigs commonly undergo a variety of routine surgical procedures including teeth resectioning, tail docking and castration of piglets in the first few days or weeks of life and tusk trimming which may be performed on boars throughout adulthood. Considerable research using behavioral and physiological measures indicates that the surgical procedures conducted on piglets during processing and castration cause acute pain. Although the age at which the procedures are performed has little effect on their painfulness per se, there can be differential effects on growth, survival and overall well-being when they are performed at certain ages; and this may be particularly important for low birth weight piglets. Various techniques are available for some procedures; for example, cauterization versus cold clipping to dock tails, clipping versus grinding of needle teeth and severing versus tearing the spermatic cords during castration. Comparisons of these different techniques have indicated that some options may be less painful than others, and that some may result in a lower stress response and less impairment to well-being if they involve less handling or take less time. Most current research is aimed at developing protocols for reducing pain during piglet processing and castration using general, local or topical anesthetics, and by administering analgesics before or following the surgeries. To date, there has been little research examining whether tusk trimming is painful for boars. Many current recommendations suggest that the tusks of boars are not innervated and that tusks should be removed to just above the gumline. However, a recent study showed that tusk trimming resulted in exposure of the pulp in over half of the tusks examined and that pulp exposure was associated with inflammation of the surrounding tissues. Histological examinations of tusks indicated that neurons were present throughout the pulp tissue. Further research on degree of pain and best practices for tusk trimming is warranted.

Key Words: swine, pain, routine surgical procedures, piglet processing

5 (Invited) Pain: A sow lameness model. A. Johnson^{*1}, J. Coetzee², K. Stalder¹, L. Karriker¹, and S. Millman¹, ¹Iowa State University, Ames, ²Kansas State University, Manhattan.

Lameness has a significant impact on animal welfare and is considered to be one of the most important causes of culling for sows in the United States. Science-based guidance for the industry on optimal housing, management and treatment of lame pigs is deficient. Furthermore, there are currently no analgesic compounds specifically approved by the Food and Drug Administration for use in lame swine. The identification and validation of robust, objective and repeatable measurements of pain caused by lameness is fundamental for the development of effective analgesic drug regimens and management strategies. Most research has focused on behavioral or physiological changes associated with acute pain but these changes can be complex, with natural variation between animals. Induction of lameness allows for controlled evaluation of lameness pain response in animals because pre- and post lameness measurements can be taken from the same animal. This approach has been published by Kotschwar et al., (2009) using an amphotericin B-induced synovitis-arthritis bovine model. In 2009, ISU and KSU researchers adapted this model to induce lameness in sows which resolves in approximately 1 wk and built the Swine Intensive Studies Laboratory to study pain using a multi-disciplinary approach. Home pen behaviors, kinematics (while standing using a force plate developed by ISU researchers and walking using a Gait-Rite system), physiologic, performance parameters and reactions that indicate sensitivity to lameness pain can be assessed simultaneously. These tools allow a non-invasive analysis of lameness pain that can be correlated with the other diagnostic tools. The long-term goal is to validate objective tools to assess pain, beginning with lameness as a model. These findings will then be used to develop pain mitigation strategies including environmental modification, management strategies and to screen candidate analgesics with favorably pharmacokinetic profiles in swine to provide proactive information to the American livestock producer.

Key Words: force plate, lameness, pain, swine

6 (Invited ASAS Animal Science Young Scholar) The impact of environmentally enriched housing on sow motivation, behavior and well-being. M. R. P. Elmore^{*1}, J. P. Garner¹, A. K. Johnson², R. D. Kirkden³, B. T. Richert¹, and E. A. Pajor⁴, ¹Purdue University, West Lafayette, IN, ²Iowa State University, Ames, ³University of Cambridge, Cambridge, United Kingdom, ⁴University of Calgary, Calgary, AB, Canada.

Sows are often housed in barren and unstimulating environments during breeding and/or gestation. Providing enrichments for which sows are highly motivated should improve their well-being. In a series of studies, gestating sows' motivation for enrichments (including: straw, compost, cotton ropes and a rubber mat), in both stall and group settings, was tested. Sows were trained to press an operant panel to access enrichments. Each day, the sows had to press more to access enrichments, and the highest number of presses indicated motivational strength. Behavior was observed to confirm enrichment use and value. When sows worked for an enriched group pen, the motivation of dominants and subordinates did not differ ($P = 0.72$). However, dominants were more aggressive ($P = 0.008$) and spent more time using enrichments ($P = 0.001$) upon pen entrance, while subordinates were more frequently displaced from enrichments ($P < 0.001$) and were less active ($P = 0.003$). Subordinates compensated for early low enrichment use by increasing use during non-peak times ($P = 0.001$). Stalled sows showed high motivation for compost (as indicated by high panel

pressing and a reduced latency to press the panel; both, $P < 0.05$) and valued access to straw (as indicated by behavioral measures, such as high enrichment use over time; $P < 0.001$), but showed low motivation for a rubber mat or a cotton rope (both, $P > 0.05$). However, when rubber mats were provided in groups, sows preferred to rest on the mats ($P < 0.05$), showed a reduction in lesions ($P = 0.03$) and demonstrated alterations in lying behavior indicative of increased comfort - i.e., increased lateral lying ($P < 0.05$) and postural adjustments ($P = 0.001$). In conclusion, stall-housed gestating sows valued access to enrichments in both individual and group settings, as indicated by motivation tests and behavioral measures. In particular, compost in a trough, straw in a rack and rubber mats were valued by sows housed in intensive systems and should be considered to improve their well-being.

Key Words: enrichments, groups, stalls

7 (Invited ASAS Animal Science Young Scholar) Optimizing individual and group housing systems based on indicators of sow well-being. A. E. DeDecker*¹, P. M. Walker², and J. L. Salak-Johnson¹, ¹University of Illinois, Urbana, ²Illinois State University, Normal.

A major public issue of global scale is farm animal welfare, more specifically how to keep gestating sows. Producers can choose from multiple housing choices but most do not equate to safeguarding sow welfare. It is imperative that we develop welfare-friendly systems based on scientific-assessments of sow welfare before implementation. Hence, the objectives of these studies were to evaluate the impact that various housing components within alternative individual-housing (Exp 1) and group-pen (Exp. 2) systems have on sow well-being. Exp 1, at d 30 of gestation, 60 multi-parious crossbred sows were randomly allotted to standard crate (CRATE; control), width adjustable crate (FLEX), or free access stall-pen (FREE). In Exp 2, 300 multi-parious sows were kept in group-pens (10 sows/pen) and randomly allotted to pens with floor-space allowance of 1.7 m² or 2.3 m² per sow and dietary treatment of control or high-fiber supplemented diet after d 30 of gestation. Prior to d 30, sows were kept in a standard (STS) or turn-around (TAS) stall. Sow performance, productivity, behavior, and immune and endocrine status were assessed at various time points throughout gestation. Data were analyzed using Proc MIXED with repeated measures (SAS). Data from Exp. 1 show that sows kept in FREE had greater ($P < 0.05$) leg swelling, lesions, backfat, and BW than sows kept in FLEX or CRATE. Sows kept in FREE had greater ($P < 0.05$) neutrophil-to-lymphocyte ratio 24 h after being placed into FREE. Sows kept in CRATE performed more ($P < 0.05$) oral-nasal-facial and stand behaviors than sows in other systems. Data from Exp. 2, indicate that sows kept in group-pens at floor-space of 1.7 m² had greater ($P < 0.05$) lesion scores than sows at 2.3 m², while sows fed a high-fiber diet had greater ($P < 0.10$) BW and BW gain than sows fed control diet. Sows fed control diet had greater ($P < 0.05$) cortisol and phagocytosis than sows fed high-fiber diet. Sows kept in STS

had greater ($P < 0.01$) total white blood cell counts and phagocytosis than sows kept in TAS. Natural sequence of maintenance behaviors were positively influenced among sows fed high-fiber diet ($P < 0.05$). These data imply that gestation-environment and physical components of housing system per se can positively and negatively impact sow welfare. Thus, optimizing housing systems that better compliment sow behavior and physiology may enhance sow well-being.

Key Words: sow, well-being

8 (Invited ASAS Animal Science Young Scholar) Assessment of sow fear, parity and season on piglet mortality in loose farrowing systems. C. E. Phillips*¹, Y. Z. Li², J. E. Anderson³, L. J. Johnston², G. C. Shurson¹, and J. Deen⁴, ¹University of Minnesota, St. Paul, ²West Central Research and Outreach Center, Morris, ³University of Minnesota, Morris, ⁴College of Veterinary Medicine, St. Paul, MN.

A study was conducted to investigate the association of sow fear, parity, and season with piglet mortality in a group-farrowing system. Multiparous sows (n = 63) from 4 breeding groups, 2 groups farrowing in summer (June and August, 2009) and 2 groups in winter (November, 2009 and January, 2010) were used. Number of sows for each parity (P) were: P2 = 7, P3 = 14, P4 = 13, and P5 to P9 = 19. Sows were subjected to the human approach and the novel object fear tests during wk 12 after breeding. A fear score for each sow was calculated from the fear tests using a Principal Component Analysis, which showed a single-dimension composed of the measurements of the fear tests (latency to approach within 0.5 m, latency to first physical contact, duration spent within 0.5m, and number and duration of physical interactions). Fear scores ranged from 0 to 7.88, with lower scores indicating less fearful. Sows were classified as less fearful (n = 32, scores = 4.36 ± 1.83) or fearful (n = 31, scores = 7.32 ± 0.42). The farrowing facility housed 8 sows (4 classified as fearful and 4 less fearful) in each room (2 rooms/group), where sows shared a communal area and farrowed in individual pens. Total born, born alive, and still born piglets in each litter, and litter weight were recorded for each sow within 24 h after farrowing. Piglet deaths were recorded daily. Stillborn piglets were determined using the lung float test. Piglets were weaned at 27 to 38 d of age. Data were analyzed by the Poisson, Gaussian, and Logistic regression models using the Glimmix Procedure of SAS. There was no significant association of sow fear with piglet mortality. The risk of piglet mortality in P2 sows was less than half the risk of P5 to P9 sows (14.93% vs. 30.30%, SE = 3.58, Odds Ratio (OR) = 0.41, 95% Confidence Interval (CI) = 0.25 to 0.66). Piglet mortality was higher in summer compared with winter (31.88% vs. 18.71%, SE = 3.58). It appears that both sow parity and season are important factors that contribute to piglet mortality in the loose farrowing system studied. However, fearfulness of sows as measured in this study did not influence preweaning piglet mortality.

Key Words: sow, fear, piglet mortality

POSTER PRESENTATIONS

Animal Behavior, Housing, and Well-Being

9 Animal-related factors affecting piglet mortality in loose farrowing systems. Y. Z. Li¹, J. E. Anderson², and L. J. Johnston¹, ¹University of Minnesota West Central Research and Outreach Center, Morris, ²University of Minnesota, Morris.

A study was conducted to investigate sow-related (sow parity, CV for birth weight within litter, early mortality of piglets) and piglet-related factors (individual birth weight, gender, cross-fostering) affecting piglet mortality in a group-farrowing system. Multiparous sows (n = 108) from 8 breeding groups were used. The farrowing barn housed 8 sows of different parity (2 to 10) in each room where sows shared a communal area and farrowed in individual pens. Piglets were weighed individually within 24 h after farrowing, at pen removal (d 10), and at weaning (d 28), from which CV within litter was calculated. Dead piglets were weighed when found. Behavior of 39 focal sows during farrowing was video-recorded, from which farrowing duration, inter-birth interval, and frequency of posture changes were determined. Data were analyzed using the Glimmix Procedure of SAS with the Tukey test for means separation. Among the 1,233 piglets born, 94.3% were born alive and 5.7% were still born. Of the live born piglets, 20% died before weaning, with 50% of the total deaths occurring during the first 3 d after farrowing. Sows of parity 5 or greater had greater piglet mortality (28% vs. 14%, SE = 2.78; $P < 0.01$) and weaned smaller litters (8.6 vs. 9.8 piglets, SE = 0.30; $P < 0.05$) than sows of parity 2. Sows that farrowed piglets with CV for birth weight greater than 20% had greater piglet mortality than sows that farrowed piglets with CV less than 15%, regardless of parity. Sows that lost piglets within 24 h after farrowing lost more piglets during the entire lactation period than sows that did not lose piglets on d 1. Piglets that died during lactation were 0.28 kg lighter in birth weight (1.393 vs. 1.673 kg, SE = 0.065; $P < 0.001$) compared with piglets that survived to weaning. Neither behavior of sows at farrowing, piglet gender, nor cross-fostering affected piglet mortality. The results indicate that parity and birth weight of piglets were the major animal-related factors that contributed to piglet mortality in the loose farrowing system studied.

Key Words: piglet mortality, parity, birth weight, farrowing behavior

10 Effects of increasing stocking density on finishing pig performance. M. L. Potter,* S. S. Dritz, M. D. Tokach, J. M. DeRouchey, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan.*

A total of 1,201 pigs were used in a 99-d trial to evaluate the effects of increasing stocking density on pig performance. Pens (3.0 × 5.5 m) of barrows or gilts were blocked to minimize variation due to gender and barn location. Pens of pigs were randomly allotted to 1 of 4 treatments (12 pens/treatment). Treatments were stocking pens with 22, 24, 26, or 28 pigs each, allowing 0.75, 0.69, 0.63, and 0.59 m²/pig, respectively. Each pen had a single 3-space, 106.7 cm long dry feeder and swinging nipple waterer. Pigs were weighed and feed intake was determined on d 0, 14, 28, 42, 56, 70, 84, and 99 to calculate ADG, ADFI, and G:F. Adjustments were not made in the pens to account for space increases due to removed pigs (1.9%, 1.0%, 1.6%, and 1.5% removals for 22, 24, 26, and 28 pigs/pen, respectively). With the exception of d 56 to 70

ADG, after d 14, as stocking density increased, ADG, ADFI, and BW decreased (linear; $P \leq 0.05$). There was no difference (linear; $P = 0.91$) in overall G:F. Overall results indicate that finisher pig ADG, ADFI, and BW increased as the number of pigs/pen was reduced. However, income over feed and facility cost per pig placed was numerically optimized (\$93.90 ± 2.22, \$94.01, \$93.41, and \$92.40 for 22, 24, 26, and 28 pigs/pen, respectively; linear, $P = 0.34$) when pens were stocked with 24 pigs each, allowing 0.69 m² of space per pig. Although increasing stocking density reduced performance, based on a critical k -value of 0.035, stocking density alone should not have affected performance until pigs reached BW of 98.1, 86.2, 75.3, and 67.9 kg for 22, 24, 26, and 28 pigs/pen, respectively.

Table 1. Effect of increasing stocking density on pig performance

Item	Pigs per pen				SEM	Linear, $P <$
	22	24	26	28		
BW, kg						
d 0	28.5	28.6	28.4	28.6	1.10	0.95
d 14	41.7	41.8	41.4	41.6	1.48	0.73
d 28	54.1	53.4	52.6	52.8	1.87	0.05
d 42	68.8	67.8	67.0	66.8	2.21	0.007
d 56	82.2	80.8	80.0	79.2	2.74	<0.001
d 70	98.3	96.5	95.5	94.9	3.12	<0.001
d 84	111.6	109.4	108.5	107.2	3.30	<0.001
d 99	125.8	122.9	121.8	119.8	3.24	<0.001
d 0 to 99						
ADG, kg	0.98	0.95	0.94	0.92	0.023	<0.001
ADFI, kg	2.52	2.43	2.39	2.36	0.095	<0.001
G:F	0.39	0.39	0.39	0.39	0.007	0.91

Key Words: growth, pig, space allowance, stocking density

11 Effects of mixing late-finishing pigs just before marketing on performance. M. L. Potter,* S. S. Dritz, M. D. Tokach, J. M. DeRouchey, R. D. Goodband, J. R. Bergstrom, and J. L. Nelssen, *Kansas State University, Manhattan.*

A total of 512 pigs were used in a 15-d trial to determine the effects of mixing late-finishing pigs from 1 or 2 barns at different stocking densities on pig performance. Pigs from 2 barns (north or south barn) were placed in 32 pens in the north barn at densities of 12 or 20 pigs/pen. Pens were allotted to 1 of 4 mixing treatments (8 pens/treatment). Treatments were: (1) non-mixed pens with 12 north barn pigs (none), (2) mixing 6 north barn pigs with 6 south barn pigs (mix1), (3) mixing 10 north barn pigs with 10 south barn pigs (mix2), and (4) mixing 10 north barn pigs with 10 more north barn pigs (mix3). A common diet was fed to pigs. Pigs were weighed and feed intake measured on d 0, 8, and 15 to determine ADG, ADFI, and G:F. Data were analyzed by a model including the effects of treatment and initial average BW. Gender was used as a random effect. All responses were adjusted to an average initial BW (166.0 kg). Pen inventories had a larger effect on performance than mixing, with pigs stocked at 12 pigs/pen having greater overall ADG ($P \leq 0.06$) and ADFI ($P \leq 0.02$) than those stocked

at 20 pigs/pen. Overall, there was no difference in performance for non-mixed pigs and mixed pigs when stocked at a similar density (12 pigs/pen). On d 15, non-mixed (129.8 ± 0.79 kg) and mix1 (129.8 ± 0.77 kg) pigs were heavier ($P < 0.01$) than mix3 (127.2 ± 0.77 kg) pigs with mix2 (128.2 ± 0.78 kg) pigs intermediate ($P \geq 0.07$). Although performance was negatively affected immediately after mixing, overall performance of mixed pigs was not different than that of non-mixed pigs.

Table 1. Mixing effect on performance

Item	None	Mix1	Mix2	Mix3	P<
d 0 to 8					
ADG, g	863 ± 91	800 ± 89	717 ± 90	660 ± 89	0.13
ADFI, g	3307 ± 128 ^a	3092 ± 124 ^{ab}	2837 ± 126 ^b	2882 ± 124 ^b	0.02
G:F	262 ± 21	256 ± 21	249 ± 21	228 ± 21	0.37
d 8 to 15					
ADG, g	981 ± 44 ^{ab}	1052 ± 43 ^a	894 ± 43 ^{bc}	850 ± 42 ^c	0.01
ADFI, g	3594 ± 106 ^a	3645 ± 103 ^a	3277 ± 105 ^b	3226 ± 103 ^b	0.003
G:F	275 ± 11	290 ± 11	271 ± 11	263 ± 11	0.38
d 0 to 15					
ADG, g	918 ± 56 ^a	918 ± 54 ^a	800 ± 55 ^{ab}	749 ± 54 ^b	0.01
ADFI, g	3442 ± 114 ^a	3350 ± 111 ^a	3041 ± 112 ^b	3042 ± 111 ^b	0.006
G:F	267 ± 10	274 ± 10	261 ± 10	246 ± 10	0.12

Key Words: growth, mixing, pig

12 A comparison of using pen versus individual sow as the experimental unit when evaluating data from sow housing studies. A. R. Hanson^{*1}, A. E. DeDecker², J. L. Salak-Johnson², and P. M. Walker¹, ¹Illinois State University, Normal, ²University of Illinois, Urbana.

By definition, an experimental unit (EU) is the smallest unit upon which a treatment is imposed in an experiment. In feeding trials where animals are group-fed, growth performance is analyzed using pen as the EU. However, if these animals are individually-fed, then the individual animal can serve as the EU. Analyzing data related to measures of animal welfare is more challenging when animals are kept in groups, because many measures of well-being are affected by the individual animal rather than the group of animals; thus data should not be analyzed on a pen-basis. The purpose of this evaluation was to compare the results and data interpretation based on statistical analysis in which the EU is either the pen or individual animal, when analyzing data of a previously reported study (JAS, Vol. 88, E Suppl. 2:461). For both statistical analyses, performance and lesion score data were analyzed using the GLM procedure of SAS to evaluate the effects of diet (D; control or high-fiber), floor space allowance (FS; 1.7 or 2.3 m² per sow), and interactions. Sow parity (SP) was used as a fixed effect and included in the interactions only when individual animal was used as EU. Replicate was a covariate in all analyses. The Mixed procedure of SAS with repeated measures was used (when appropriate) to include day of gestation (GD) in the model and interactions. Significance was detected when $P \leq 0.05$. When data were analyzed using individual animal as EU, significant effects of D x SP and D x SP x GD were found for sow performance (ADG and sow BW, respectively), and a significant effect of FS x SP was detected for total skin lesion severity. If pen was used as the EU, treatment interactions with SP were not detected, partly because SP was excluded from model. Pen mean SP could be included as a covariate, but mean SP limits interpretation of results because sows from different parities may respond differ-

ently to treatments. These data imply that researchers should consider using individual animal as the EU rather than pen for all measurements except ADFI, DMI and G:F for loose housing studies when there are a large number of sows per pen and a limited number of pens are utilized, so that the effect of sow parity level can be evaluated.

Key Words: experimental unit, sow housing analyses, sow welfare, group housing

13 Comparison of CO₂ versus mixed CO₂:Argon gas at different flow rates using the Smart Box euthanasia device as a humane and effective method of piglet euthanasia. L. Sadler^{*1}, C. Hagen², C. Wang¹, and S. Millman¹, ¹Iowa State University, Veterinary Diagnostic and Production Animal Medicine, Ames, ²Value-Added Science and Technologies, Ames.

The objective of this study was to compare the effectiveness of CO₂:Argon (CA) gas mixture relative to CO₂ when applied to weaned piglets 15 to 20 d of age. A total of 180 piglets, BW 4.6 ± 0.7 kg, were utilized. A 2 x 4 factorial design compared 2 gas mixtures (100% CO₂ and 50:50 CA) and 4 flow rates: slow (SL), medium (MD), fast (FT), and prefill (PF); 20%, 35%, 50%, and prefill with 20%, chamber volume per minute respectively. Two piglets were placed in a plastic chamber with the lid and one side composed of Plexiglas to facilitate behavior observations. A Smartbox device (Euthanex Corp, Palmer, PA) was used to supply gas at controlled rates. Piglets were scored using direct observation for latency to perform 3 behaviors associated with insensibility: loss of posture (LP), last movement (LM) and gasping (GSP). Open mouth breathing (OMB) occurred before insensibility and was used as an indicator of distress. LP, GSP, and OMB were analyzed using univariate product-limit estimation of the survival curves. LM data was log-transformed and analyzed using a mixed model with fixed effects of sex and trt, and blocked by day of trt. Significance was determined at $P \leq 0.05$ using a Sidak correction for multiple comparisons. Mean treatment latencies for LM ranged from 269 ± 73 s (PF CO₂) to 775 ± 216 s (SL CA). Latency for LM was significantly greater in CA trts, with average differences ranging from 123 s longer (PF) to 246 s longer (SL). Gas trts did not differ for OMB, GASP or LP. Gas flow rate significantly affected LM, with SL taking longer than MD, FT, or PF (CO₂ 529 ± 181 , 312 ± 40 , 274 ± 27 , 296 ± 73 ; CA 774 ± 216 , 467 ± 37 , 397 ± 32 , 491 ± 209). For all other parameters, no significant differences were observed for flow rate. In conclusion, CA and SL prolonged the latency for insensibility, as measured by LM and did not confer advantages for measures of distress (OMB). We are further exploring the aversiveness of gas mixtures and flow rates using more sensitive video and acoustic analysis.

Key Words: swine, euthanasia, carbon dioxide, argon

14 Impact of floor space on the grow-finish performance of barrows and gilts in a commercial facility. C. M. Shull^{*1}, M. Ellis¹, B. A. Peterson², B. F. Wolter², R. Bowman², C. M. Peterson², C. L. Puls¹, L. Ochoa¹, and B. W. Isaacson², ¹University of Illinois, Urbana, ²The Maschhoffs, Carlyle, IL.

The effects of floor space and gender on growth performance and carcass characteristics were evaluated in a commercial wean-to-market facility using a randomized complete block design with a 2 x 3 factorial arrangement of treatments: 1) floor space (0.56 and 0.65 m²/pig; 154 and 132 pigs/pen, respectively); 2) gender (barrows, gilts, and mixed-gender). There were an equal number of barrows and gilts

in the mixed-gender pens. The study was carried out using 3 replicates with 2,593 pigs between a mean pen BW of 37.5 ± 1.21 kg (10 wks post-weaning) and 123.8 ± 1.80 kg. Pigs had ad libitum access to feed and water throughout the study. Pigs were sent to a commercial plant at 132.6 ± 1.41 BW for harvest and carcass measurements. Pigs at the lower floor space (0.56 m²/pig) had lower overall ADG (4.4%, $P \leq 0.01$) and required more days to reach 123.8 kg BW (4.6%, $P \leq 0.01$), but had greater total BW gain per unit of floor space (11.0%, $P \leq 0.001$) than those at 0.65 m²/pig. There was no effect ($P \geq 0.05$) of floor space on the incidence of morbidity and mortality. Pigs housed at the lower floor space had numerically lower (2.9%, $P = 0.12$) 10th rib backfat and lower (1.4%, $P \leq 0.05$) *Longissimus* muscle depth. There were no floor space by gender interactions ($P \geq 0.05$), suggesting that genders responded similarly to the reduced floor space. The results of this study suggest that the lower floor space evaluated reduced growth rate, but increased the total live weight produced per pen and, also, carcass leanness.

Key Words: floor space, gender, growth, pigs

15 Impact of reduced floor space on the growth response of pigs of two live weights. C. M. Shull^{*1}, M. Ellis¹, B. A. Peterson², B. F. Wolter², and C. M. Peterson², ¹University of Illinois, Urbana, ²The Maschhoffs, Carlyle, IL.

Two studies were carried out over 2 weight ranges to determine the growth response of pigs to varying floor spaces. Study 1 was carried out between 24.2 ± 1.29 kg and 47.9 ± 2.08 kg (wk 6 to 10 post-weaning) and Study 2 was carried out between 60.8 ± 2.11 kg and 84.5 ± 2.55 kg (wk 12 to 16 post-weaning). A randomized complete block design with 5 floor space levels (0.21, 0.27, 0.33, 0.39, and 0.44 m²/pig in Study 1; 0.35, 0.45, 0.54, 0.64, and 0.73 m²/pig in Study 2) was used. Floor spaces covered the range likely to be used in practice and provided the same k values in both studies (i.e., 0.019, 0.025, 0.030, 0.035, and 0.041 m²/BW^{0.67}, respectively). Study 1 used 3,000 pigs in 15 replicates with 40 pigs per pen. The same pens of pigs were re-allotted for Study 2; group size was reduced to 29 pigs/pen, giving a total of 2,175 pigs in 15 replicates. Growth performance was also measured during the subsequent 2-wk period between the studies and at the end of Study 2 during which all pigs were kept at the same floor space (0.53 and 0.73 m²/pig for the period following Study 1 and 2, respectively). In Study 1 and 2, ADG was decreased ($P \leq 0.001$) by 17.9 and 42.1%, respectively, and ADFI was decreased ($P \leq 0.001$) by 14.4 and 28.6%, respectively, from the highest to lowest floor space treatment levels. Also, in both studies G:F was lower ($P \leq 0.001$) for the 2 lowest floor spaces. There was no clear relationship between morbidity and mortality level and floor space treatment level in either study. During the 2-wk periods at the end of both Study 1 and 2, G:F generally increased ($P \leq 0.001$) with decreasing previous floor space. The results of these studies suggest that decreasing floor space can cause significant reductions in ADG, ADFI, and G:F; however, feed efficiency can be improved by providing increased floor space subsequent to a floor space restriction.

Key Words: floor space, growth, pigs

16 Effect of large group size and timing of formation of large groups on the wean-to-finish growth performance and carcass characteristics of pigs housed in a commercial facility. C. M. Shull^{*1}, M. Ellis¹, B. A. Peterson², B. F. Wolter², R. Bowman², C. M. Peterson²,

and L. Ochoa¹, ¹University of Illinois, Urbana, ²The Maschhoffs, Carlyle, IL.

The objective of this study was to evaluate the timing of formation of large groups of pigs on wean-to-finish growth performance and carcass characteristics. The study was carried out in a commercial facility and involved 3,192 pigs in 8 replicates using a randomized complete block design (blocking factor = day of weaning) with 3 treatments: 1) large group size (171 pigs) formed at weaning; 2) small group size (57 pigs) formed at weaning; 3) small group size (57 pigs) formed at weaning mixed to form large groups (171 pigs) at wk 8 post-weaning. Pigs were kept at a floor space of 0.59 m²/pig and had ad libitum access to feed and water throughout the study. Growth performance was measured from weaning (5.9 ± 0.35 kg) to wk 18 post-weaning (96.9 ± 3.56 kg); pigs were sent to a commercial packing plant for harvest and carcass measurements at 122 kg BW. Growth and carcass data and morbidity and mortality data were analyzed using the PROC MIXED and PROC FREQ procedures of SAS, respectively. Large groups (Trt. 1) grew slower (6.1%; $P \leq 0.05$) from weaning to wk 8 and were lighter (4.2%; $P < 0.05$) at wk 8 compared with small groups (Trt. Two and 3). There was no effect ($P \geq 0.05$) of treatment on growth rate from wk 8 to 18 or for the overall study period. Morbidity and mortality incidence over the 18 wk study period was greater ($P \leq 0.01$) for Trt. One than for the other 2 treatments (8.9, 6.0, and 5.8% for Trt. 1, 2, and 3, respectively). No differences were observed between treatments for carcass characteristics. The results of this study suggest a negative effect of the large groups on nursery but not overall growth performance. The higher incidence of morbidity and mortality when the large groups were formed at weaning is of concern and requires validation.

Key Words: group size, pigs, growth, carcass

17 Head-only followed by cardiac arrest electrical stunning is an effective alternative to head-only electrical stunning in pigs. K. D. Vogel^{*1,2}, G. Badtram³, J. R. Claus⁴, T. Grandin², S. Turpin⁴, R. E. Weyker⁴, and E. Voogd⁵, ¹University of Wisconsin, Department of Animal and Food Science, River Falls, ²Colorado State University, Department of Animal Sciences, Fort Collins, ³Wisconsin Department of Agriculture, Trade, and Consumer Protection, Division of Food Safety, Madison, ⁴University of Wisconsin, Department of Animal Sciences, Madison, ⁵Voogd Consulting, Inc., West Chicago, IL.

Many small slaughter facilities use head-only electrical stunning to render swine unconscious and insensible to pain before slaughter. Head-only electrical stunning is a reversible procedure that is optimally effective for approximately 15 s following stun completion. Shackle to bleed time in small slaughter facilities may exceed 30 s due to slow hoist speed. As a result, a 2-stage stunning method was proposed where head-only stunning for 3 s is immediately followed by application of the same stunning wand to the cardiac region of the animal for 3 s while lying in lateral recumbancy (head/heart). A paired-comparison study was performed on 89 pigs in a small WI slaughter facility to compare the head-only method applied for 6 s to the head/heart method. The objective was to evaluate signs of return to sensibility, stun to bleed time, blood lactate concentration, muscle pH, drip loss, and fresh meat color to validate the head/heart electrical stunning method for small slaughter plants. Categorical data were analyzed with Fisher's Exact Test and all other data were analyzed with Tukey's Test. Incidence of corneal reflex was not different ($P > 0.05$) between head/heart (93.8%) and head only (85%) stunning. Nose twitching was more common ($P < 0.05$) in head only (26.5%) than head/heart (5%) stunning. The head/heart method eliminated rhythmic breathing, natural

blinking, eye tracking to a moving object, and righting reflex, which were all observed in head-only stunned pigs. Eye tracking to moving objects was observed in 40.8% of head-only stunned pigs. Blood lactate was not different ($P > 0.05$) between stunning methods (head only: 8.8 ± 0.7 mmol/l, head/heart: 7.8 ± 0.7 mmol/l). Stun to bleed time did not differ ($P > 0.05$) (head only: 32 ± 1 s, head/heart: 33 ± 1 s). Mean time to loss of detectable heartbeat with the head-only method was 121 ± 5 s. No detectable heartbeat was observed with the head/heart method. Longissimus thoracis pH, color, and drip loss were not different ($P > 0.05$) between stunning methods. The head/heart electrical stunning method reduces the incidence of signs of return to sensibility without significant effects on meat quality or plant operation speed. In addition, this method requires no capital investment for plants that are currently using the head-only method.

Key Words: insensibility, slaughter, swine, welfare

18 Objective pain assessment in sows with induced transient lameness. K. Tapper*¹, A. Johnson², L. Karriker³, K. Stalder², J. Coetzee⁴, R. Parsons³, and S. Millman^{1,3}, ¹*Iowa State University, Department of Biomedical Sciences, Ames*, ²*Iowa State University, Department of Animal Sciences, Ames*, ³*Iowa State University, Department of Veterinary Diagnostic and Production Animal Medicine, Ames*, ⁴*Kansas State University, College of Veterinary Medicine, Manhattan*.

Objectives of this study were to evaluate 2 methods of pain assessment, pressure algometry and thermal sensitivity, in sows with induced transient lameness. Twelve mixed parity crossbred sows were anesthetized and injected with amphotericin B in the distal interdigital space of one hind leg to temporarily induce lameness. Lameness was induced in the

same leg for each sow during 3 trials conducted over a 3-mo period. Data were collected on Day-1 and Day+1 relative to lameness induction (Day 0). A hand-held pressure algometer with a 1 cm² flat rubber tip was used to measure mechanical nociceptive thresholds (MNTs) in kilograms of force (kgf). Pressure was applied perpendicularly to 3 landmarks (Cannon (C), Inner Claw (I), and Outer Claw (O)) on each hind leg (Lame (L) and Sound (S)). When a foot-lift response was observed, peak MNT was recorded. A thermal sensitivity test measured latency for withdrawal response to a focused radiant heat light directed at the coronary band. Data were tested for normality and paired *t*-tests were used for analyses. On Day-1, S vs. L MNTs were not significantly different in the algometer test. On Day +1, lower MNT values were observed for all landmarks ($P < 0.0001$) on the L leg (mean change in MNT \pm SE: C -2.89 ± 0.32 kgf; I -5.87 ± 0.23 kgf; O -6.56 ± 0.23 kgf), whereas S did not differ from their baseline values. For each algometer landmark, lower MNT values were observed on the L vs S leg on Day+1 (mean difference \pm SE: C -4.06 ± 0.31 kgf; I -6.62 ± 0.33 kgf; O -6.09 ± 0.32 kgf, $P < 0.0001$). Similarly, lower latencies were observed in the thermal test for L vs. S on Day+1 (-3.54 ± 0.62 s, $P < 0.01$). However, this difference was also seen on Day-1, before lameness induction (-1.75 ± 0.66 s, $P = 0.01$), and greater thermal sensitivity occurred on Day +1 for both L and S compared with Day-1 (L -4.08 ± 0.57 s, $P < 0.01$; S -2.29 ± 0.71 s, $P = 0.01$). In conclusion, these results support pressure algometry as an objective noninvasive method for measuring pain sensitivity in sows induced with transient lameness. Thermal sensitivity will require further analysis to determine validity.

Key Words: algometer, lameness, pain, swine

Tuesday, March 15, 2011

SYMPOSIA AND ORAL SESSIONS

Billy N. Day Symposium: The Replacement Gilt

19 (Invited) Genetics and development of replacement gilts. R. K. Johnson* and P. Miller, *University of Nebraska, Lincoln*.

An efficient sow herd begins with selection and development of replacement gilts, which should be F1 crosses of lines selected for maternal performance. Heritabilities of fertility traits are: age at puberty and at first service (30 to 40%), litter size (~10%), and wean to service intervals and return to estrus rates (2 to 10%). Various fertility indexes, such as one proposed for Norway including age at first service, number of live pigs per litter, and 1st parity weaning to service, have been proposed. Prolonged periods of post-weaning energy restriction without limiting other nutrients results in increased longevity in many animals. But in some species allocation of resources is such that animals cannot combine high rates of fecundity with extended lifespan. This axiom does not hold in mice when caloric restriction is imposed after females wean their 1st litter - fecundity and lifetime energy intake are negatively related. In one study, moderate feed restriction during pre-pubertal development of gilts increased reproductive efficiency through 1st parity (P1). We estimated the effects of energy restriction from 123 d of age to breeding at 235 d of age on production through Parity 4 using 661 gilts of 2 lines. Gilts were developed with either ad libitum access to feed (A) or restriction (R) of energy intake to 75% of that of AL. Although not significant, number of live pigs through P4 was 7.1% greater for gilts developed with R than A and 9.6% greater for the cross of prolific lines. The younger a gilt at puberty, the more likely she was to produce a P1 litter ($P < 0.002$), but the likelihood of producing a P1 litter was not affected by BW at any age or backfat ($P > 0.35$). Enhanced lifetime productivity is expected in F1 gilts of lines selected for decreased age at puberty, increased live pigs born, and 1st parity rebreeding rate.

Key Words: genetics, gilt development, longevity, pig

20 (Invited) Induction of puberty and synchronizing estrus. M. J. Estienne,* *Virginia Tech, Blacksburg*.

Swine producers annually replace in excess of 50% of sows with gilts and introduction of females into the breeding herd is a significant component of the overall efficiency of the enterprise. It is very important that a high proportion of selected gilts reach puberty at an early age, conceive and enter weaned sow groups. Age at puberty is affected by both genetics and environment. Visual, auditory, olfactory and tactile cues emanating from the boar advances the onset of puberty. Age of gilts at which exposure to boars is most effective varies among herds but increasing the age at first contact improves timing and synchrony of estrus expression. The response of gilts to boar exposure is influenced by the type of contact (direct versus fence-line), age of boar, and frequency and duration of exposure. P.G. 600 (Intervet/Schering-Plough Animal Health; De Soto, KS) is a combination of eCG (400 IU) and hCG (200 IU) that is labeled for advancing onset of puberty in gilts, but efficacy varies among farms. Recent work from our labo-

ratory suggests that some of the poor response rates may be due to the inadvertent treatment of gilts already cycling, and P.G. 600 given around d 12 of the estrous cycle may induce formation of accessory corpora lutea and extend the inter-estrus interval. Matrix (Intervet/Schering-Plough Animal Health) is a progestogen that effectively synchronizes estrous cycles in mature, cycling gilts when fed at a rate of $15 \text{ mg} \cdot \text{d}^{-1}$ for 14 d. We have demonstrated efficacy of a system for synchronizing estrus in groups of gilts that contain a mix of prepubertal and mature, cycling females, or in groups of gilts, the cycling status of which is unknown. All animals receive Matrix for 14 d and 24 h after the last feeding, all gilts receive an injection of P.G. 600; The cycling gilts display estrus in approximately 5 d after discontinuation of Matrix (and in these animals P.G. 600 increases ovulation rate compared with animals receiving Matrix only), and in response to P.G. 600, the prepubertal gilts display estrus in approximately 4 d.

Key Words: gilts, estrus, gonadotropin, progestogen

21 (Invited) Prewaning management of replacement gilts and sow longevity. W. L. Flowers,* *North Carolina State University, Raleigh*.

Annual sow replacement rates in the US vary between 31% and 89%. Key reproductive developmental events occur during the first 100 d of a gilt's life. Consequently, it is reasonable to speculate that management early during sexual maturation can have profound effects on performance as an adult. The primary purpose of this presentation is to briefly review recent work examining the influence of the pre-weaning environment of replacement gilts on sow longevity. A study was conducted in an 80,000 sow commercial swine production system that examined the effect of the neonatal environment of future replacement gilts on their subsequent reproductive performance through 6 parities. Between 1 and 2 d of age, gilts born in litters of 10 to 12 pigs were randomly assigned to nurse in litters of ≤ 7 ($n = 1100$) or ≥ 10 ($n = 1157$) piglets via strategic cross fostering. After weaning, gilts from both neonatal treatments were managed identically and eventually bred and entered production on commercial farms at 240 ± 10 d of age. Their reproductive performance was monitored over 6 parities. Of the 2257 gilts cross fostered during lactation, 899 and 921 gilts weaned from litters of ≤ 7 and ≥ 10 pigs, respectively were bred and entered production. After 6 parities, 38% of sows raised in litters of ≤ 7 pigs were still in production compared with 16% of their counterparts weaned from litters of ≥ 10 pigs ($P \leq 0.05$). Farrowing rates and numbers of pigs born alive for sows weaned from small and large lactation litters were $88.7 \pm 1.8\%$ versus $83.3 \pm 2.1\%$ ($P \leq 0.05$); and 11.0 ± 0.2 versus 10.5 ± 0.2 ($P \leq 0.07$), respectively. Pre-weaning growth and weaning weights of the replacement gilts raised in small litters were greater ($P \leq 0.05$) than their counterparts reared in large litters. Multiple regression analyses identified pre-weaning gain ($P \leq 0.05$), weaning weight ($P \leq 0.05$) and birth weight ($P \leq 0.10$) as significant

sources of variation for sow longevity. Subsequent studies have demonstrated that gilts raised in small litters appear to have an increased responsiveness to both gonadotropins and estrogens which may be one of the physiological mechanisms through which their longevity was enhanced. In summary, enhancement of growth during the neonatal environment appears to have a positive effect on the development of key reproductive events in gilts which, in turn, positively affects their reproductive longevity.

Key Words: gilts, longevity, preweaning, growth

22 Danbred North America. T. T. Stumpf,* T. A. Rathje, and J. P. Sonderman, *Danbred North America, Columbus, NE.*

Danbred North America was reorganized under new ownership in 2003. The purchase involved 500 purebred Danish Duroc (Line 600) sows, boar studs and 2 maternal lines. Due to a tornado which destroyed the maternal nucleus, all maternal lines were culled to terminal market in 2004 and new imports of Danish Landrace (Line 400) and Danish Yorkshire (Line 200) were completed. Via new construction and acquisition of facilities the Duroc herd in North America has grown to 900 sows, the Landrace herd is to 1100 sows and the Yorkshire herd is at 1050 sows. Inventory of the purebred lines is divided across several sow units for biosecurity. The boar stud capacity has grown to 1,665 spaces with facilities in NE, MN, MB and ON. Three performance testing facilities are utilized and all data collected from the United States nucleus is transferred to Denmark for inclusion in the International database. Fresh semen is imported weekly from Denmark. All selection criteria and traits measured are via Danish protocols. All indexes are calculated as part of the Danish purebred herd. The terminal and maternal indexes are updated every 2 to 3 years to reflect the current economic value of individual traits to the pig producer. Starting in October 2010, genomic information from the 60K SNP-chip for pigs is utilized to enhance the prediction of breeding values within the Duroc line. The combined inventory of pure females from Denmark and North America (Duroc = 3,000 hd; Landrace = 4,400 hd; Yorkshire = 4,000 hd) yields the largest coordinated breeding system in the world resulting in more genetic gain compared with any smaller system.

Key Words: Danbred, duroc, landrace, yorkshire

23 Changes in the productivity of the PIC gilt. A. M. Williams and N. H. Williams,* *PIC North America, Hendersonville, TN.*

Genetic progress is achieved by continually making improvements through selection and is important to maintaining competitiveness in the swine industry. Producers are not managing the same female today that they were 20 years ago because of the application of constant selection pressure for specific traits. Maternal females are selected based on many traits including litter size, structural soundness, milk production and number of functional teats. It is imperative to incorporate many traits in the selection process and not select based solely on a single trait, such as litter size. While selecting for litter size will improve the number of pigs per litter, this is just one of several factors that impact producer profitability. Genetic trends for PIC females on a yearly basis over a 5 year period include improvements of 0.08 total number

born per litter, -0.17% stillborns, 0.51 pigs weaned/sow/year, 4.94 kg weaned/sow/year, 0.22 functional teats and 0.096 improvement in leg structure or durability. With genetic changes comes the challenge of managing a different female and PIC recommendations for gilt development has concomitantly evolved. The most important factor for success in the herd is gilt body weight at breeding. Body weight not only impacts her productivity as a first parity female, but will continue to affect her lifetime performance. The PIC target for body weight at breeding is 136 to 145 kg. Physiological age and boar exposure are 2 other elements central to gilt development. Gilts should be bred at their 2nd or later recorded estrus, as research indicates breeding gilts sooner than this decreases productivity in their first parity. Boar exposure should start at 24 weeks of age and > 70% of gilts are expected to display their first standing estrus within 3 weeks. Other indicators such as chronological age and backfat depth are not as important as previously thought. In summary, continual genetic selection based on several traits has improved performance of the PIC female. Producers must adapt management practices to optimize female lifetime performance and maintain a competitive advantage in the marketplace.

Key Words: genetic selection, gilt development

24 Gilt productivity based on her mother's experiences. M. J. Estienne,* *Virginia Tech, Blacksburg.*

Stimuli to which pigs are exposed in utero results in developmental adaptations with lifelong physiologic consequences. Growth and reproduction is impacted by fetal programming due to: 1) intrauterine growth retardation (IUGR), and 2) management of the gestating sow. An unintended effect of increased litter size in swine has been an increase in the proportion of IUGR pigs. Pigs born with the IUGR phenotype have greater rates of pre-weaning mortality and poorer postnatal growth; at slaughter, IUGR pigs have less muscle, are fatter, and have poorer meat quality. Reproductive performance may also be affected. Runt pigs had fewer primary and secondary follicles than normal weight littermates, indicating IUGR delayed follicular development. In a study conducted in our laboratory, age at puberty was negatively correlated with average pig birth weight. Relatively little research has been conducted to determine effects of sow management on fetal programming. Most studies have examined the effects of experimentally subjecting pregnant sows to stress conditions on the future performance of offspring, with a postulate being that at least some fetal programming occurs as a consequence of enhanced cortisol secretion. Sows subjected to daily restraint for 5 min during wk 12 to 16 of gestation farrowed gilts that were older at puberty than gilts farrowed by control sows. We compared growth and reproduction in gilts farrowed by sows that were kept in individual crates or group pens throughout gestation, or individual crates for the first 30 d post-mating and then group pens for the rest of pregnancy. Fewer gilts farrowed by sows kept in crates throughout gestation reached puberty by 165 d of age compared with the other groups. In summary, evidence suggests that reproduction in gilts can be affected by fetal programming. There is a need for strategies to rescue pigs with the IUGR phenotype. Because hyper-activation of the hypothalamic-pituitary-adrenal axis in sows may have long-term consequences on the fetus, producers should minimize factors that result in stress to the breeding herd.

Key Words: gilt, fetal programming, intrauterine growth retardation

Monday, March 14, 2011

POSTER PRESENTATIONS

Breeding and Genetics

25 Genome-wide association study for puberty onset and lifetime productivity in sows. J. K. Tart*¹, N. N. Ferdinand¹, S. D. Kachman¹, A. M. McKnite¹, X. Wang², P. S. Miller¹, R. K. Johnson¹, and D. C. Ciobanu¹, ¹University of Nebraska, Lincoln, ²University of Tennessee Health Science Center, Memphis.

Selection for sow lifetime productivity is difficult due to long generation intervals and the inability to identify, with precision, superior animals at an early age. Age at puberty (AP) is a trait with moderate heritability and large variance that can serve as an early indicator of lifetime productivity. However, detection of puberty onset is labor intensive and therefore not used as a selection tool in most herds. By identifying genetic markers associated with early AP we can more efficiently select replacement gilts with superior lifetime productivity.

Gilts from two maternal crossbred lines developed with ad libitum and energy restricted diet (75% of ad libitum) expressing differences in reproduction and growth were profiled for reproductive and lifetime productivity traits. AP was determined by boar exposure beginning at 140 d of age and ending at 230 d of age. Gilts were maintained through four parities with culling for reproductive or structural problems only. All 639 gilts expressing puberty by 230 d were genotyped for 62,183 Single Nucleotide Polymorphisms (SNP) using the Porcine 60K SNP BeadArray. A genome-wide association analysis using a Bayes C approach was performed to estimate the trait variance explained by each SNP with diet, replicate and crossbred line included as covariates. Clusters of SNPs associated with large variation in AP were detected on chromosomes 1, 2, 10 and 14. SNPs located on two regions of chromosome 1 that were associated with variation in AP also appeared to influence lifetime productivity traits, such as total number of live born pigs and total weaning weights. Incorporation of these SNPs into breeding programs has the potential to improve sow lifetime productivity and overall swine production.

Key Words: genome, longevity, puberty, swine

26 Differential response to infection in an experimental challenge with porcine circovirus 2b. T. Bohnert*¹, A. McKnite¹, J. Galeota¹, T. Moural¹, S. Harris¹, S. Brewer², X. Wang³, M. Rothschild⁴, S. Kachman¹, R. Johnson¹, and D. Ciobanu¹, ¹University of Nebraska, Lincoln, ²University of Wyoming, Laramie, ³University of Tennessee Health Science Center, Memphis, ⁴Iowa State University, Ames.

Porcine Circovirus 2 (PCV2) causes PCV2 associated diseases (PCVAD) that decrease growth and increase mortality. Disease progression is influenced by host genetics and other pathogens, including Porcine Respiratory and Reproductive Syndrome, Mycoplasma hyopneumoniae, and Swine Influenza. Barrows (n = 81) of 2 lines were infected at ~35 d with a PCV2b strain isolated at the University of Nebraska. Nine control barrows received no inoculation. Pigs were weighed and bled weekly. IgG, IgM, and viremia in serum were

recorded. Infected pigs were classified on IgM into early (n = 33), late (n = 40), and non-responders (n = 7). Other traits were fitted to a mixed model with fixed effects of group and line and random effect of litter. Correlations among variables, adjusted for line effects, were calculated. Means of viral load for the entire challenge differed ($P < 0.01$) between early and no response groups (124.1 and 104.1, respectively) and late and no response groups (127.5 and 104.1, respectively). The correlation between average daily gain (d 21 to 28) and overall viral load for all time points were between -0.22 and -0.29 ($P < 0.05$). Viremia differed among groups ($P < 0.01$) at d 14, 21, and 28. At d 7, 14, 21, and 28, viremia for pigs with no IgM response was 9%, 18%, 22%, and 16% less than for pigs with early and late responses. Virus replication in the pigs with no response was inhibited. Variation in immune response can be used in genomics studies to identify genetic markers for disease resistance. Application of genetic markers in selection programs will improve animal health and welfare and reduce production costs. These results represent initial efforts to establish an extensive data set of samples and phenotypes that will be used to uncover genes and DNA markers associated with PCVAD resistance.

Key Words: swine, porcine circovirus 2, disease resistance

27 Population structure of the American Simmental breed. L. Whitacre and M. L. Spangler,* *University of Nebraska, Lincoln.*

The objective of the study was to determine the structure of the Simmental breed by using a pedigree of 652,249 animals born to 19,097 breeders between 1986 and 2008. Population structure was determined by analyzing 4 pathways of selection including sire of sire (SS), sire of dam (SD), dam of sire (DS) and dam of dam (DD). Breeders within the pathways may not be breeders of calves born from 1986 to 2008 if they no longer register calves. Breeder and state code were available for all pathways of animals born in the 23 yr period. Breeders with the greatest contribution to a particular pathway were accumulated until they accounted for 10, 25, 50 or 75% of animals in the pathway reported as number of breeders. For SS, 3, 9, 29, and 102 breeders accounted for 10, 25, 50, and 75% of animals, respectively. For SD, 5, 22, 100, and 419 breeders accounted for 10, 25, 50, and 75% of animals, respectively. For DS, 5, 19, 81, and 369 breeders accounted for 10, 25, 50, and 75% of animals, respectively. The pathway with the most breeders was DD where 16, 81, 361, and 1,360 breeders accounted for 10, 25, 50, and 75% of animals, respectively. The number of breeders that produced at least one SS, SD, DS and DD were 3,466, 7,179, 8,168, and 15,291, respectively. States that contributed the greatest to the 4 pathways were also determined. Of the total number of animals in a pathway, Montana had the greatest proportion of SS, SD, and DS totaling 14.6, 16.9, and 12.1%, respectively. Other top states in proportion of animals within SS were South Dakota (7.9%), Texas (6.5%), Kansas (6.4%), and North Dakota (6.4%). For SD, the top states included South Dakota (9.4%), Texas (9.1%), Kansas (6.7%), and North Dakota (5.5%). In the DS pathway, the top states were Texas (8.2%), Kansas

(7.7%), South Dakota (6.7%), and Nebraska (5.6%). The most influential DD states were Texas (11.8%), South Dakota (8.7%), Montana (8.6%), North Dakota (7.4%), and Kansas (6.6%). Results suggest that there is a clear delineation of the Simmental breed into nucleus and multiplier levels and that these nucleus herds reside in a small number of states.

Key Words: beef, population structure, simmental

28 An iterative approach for efficient calculation of breeding values and genome-wide association analysis using weighted genomic BLUP. X. Sun,* R. L. Fernando, D. J. Garrick, and J. C. M. Dekkers, *Iowa State University, Ames.*

The Markov Chain Monte Carlo sampling used in Bayesian model averaging of genomic selection can be inefficient when estimating thousands of SNP effects but can be avoided by an iterative best linear unbiased prediction (BLUP) method. First, the genomic relationship matrix (GRM) assuming equal contributions of all SNPs is constructed from SNP genotypes and an animal model with GRM-structured breeding values is solved to obtain genomic estimated breeding values (GEBV) of all individuals. This can be done effi-

ciently because inverting a matrix with order of the number of records is feasible. Then BLUP of SNP effects are backsolved from GEBV and genotypes using selection index equations, after which the iteration starts. In each step of iteration the GRM is modified by weighting each SNP by the square of its estimated effect from the previous step plus a constant as a lower threshold, and new GEBV are obtained by solving the animal model using the updated GRM. This approach was tested on the simulated data set from the 14th QTL-MAS Workshop with 3,226 individuals in 5 pedigreed generations with phenotypes for a quantitative trait and genotypes for 10,031 SNPs. The first 4 generations were used for training and the fifth for validation. When the lower threshold was set to a small constant, the accuracy of GEBV in validation converged to a value (0.88) higher than the accuracy from BayesB (0.83). When the lower threshold was set to zero, most SNPs with small effects were eliminated from the GBLUP model and the accuracy converged to a value (0.84) less than the maximum. However, the SNPs that remained in the model were close to the QTL. In conclusion, the iterative genomic BLUP approach is an efficient method to compute genomic EBV and identify SNPs with important associations with phenotype.

Key Words: GBLUP, genomic selection, weights

Tuesday, March 15, 2011

SYMPOSIA AND ORAL SESSIONS

Breeding and Genetics

29 Persistence of accuracy of estimated breeding values in layers using marker and pedigree based relationship matrices. A. Wolc*^{1,2}, J. Arango³, P. Settar³, J. E. Fulton³, N. P. O'Sullivan³, R. Preisinger⁴, D. Habier², R. Fernando², D. J. Garrick², S. J. Lamont², and J. C. M. Dekkers², ¹Department of Genetics and Animal Breeding, Poznan University of Life Sciences, Poznan, Poland, ²Iowa State University, Department of Animal Science, Ames, ³Hy-Line International, Dallas Center, IA, ⁴Lohmann Tierzucht GmbH, Germany.

Marker based EBV (GEBV) exploit linkage disequilibrium between markers and QTL as well as relationships between animals, whereas pedigree BLUP relies completely on known ancestral relationships. The accuracy of GEBV is therefore expected to be more persistent across generations than pedigree based EBV as the meiotic distance between training and validation populations increases and the level of genetic relationships decreases, as has been confirmed by simulation. The objective of this study was to quantify this persistence over 6 generations using real data. The training population consisted of 295 genotyped animals from one generation from a brown-egg layer breeding line and phenotypes of 2,738 of their non-genotyped relatives. Validation included phenotyped and genotyped birds from 5 subsequent generations (on average 306 birds/generation). Birds were genotyped for 23,356 segregating SNPs. An animal model and a reduced animal model with fixed effects of hatch within generation were fitted to the training data using pedigree based or genomic relationship matrices, respectively. Genomic relationships were constructed following VanRaden (2008). Accuracy was evaluated as the correlation between EBV and phenotype in validation divided by square root of heritability. The table shows accuracies of pedigree and genomic EBV by generation averaged over 16 traits, including production and egg quality traits. Because genetic relationships are reduced by 50% every generation, accuracy was expected to decrease by the square root of 0.5 every generation, which was as observed for pedigree based EBV but the accuracy of GEBV was more persistent. In conclusion, GEBV capture information beyond genetic relationships. Partially funded by USDA NIFA AFRI Award 2010-65205-20341.

Table 1. Accuracy of EBV from training on generation 1 in subsequent generations using pedigree (PEBV) and marker based (GEBV) models, compared to the expected decline of accuracy based only on the decay of relationships (GEBVexp and PEBVexp)

Generation	GEBV	GEBVexp	PEBV	PEBVexp
2	0.44		0.35	
3	0.34	0.31	0.19	0.25
4	0.29	0.22	0.18	0.17
5	0.30	0.16	0.08	0.12
6	0.27	0.11	0.10	0.09

Key Words: accuracy, GBLUP, relationships

30 Accuracy of genomic EBV using an evenly spaced, low-density SNP panel in broiler chickens. C. Wang*¹, D. Habier¹, A. Kranis², K. A. Watson², S. Avendano², D. J. Garrick¹, R. Fernando¹, S. J. Lamont¹, and J. C. M. Dekkers¹, ¹Iowa State University, Department of Animal Science, Ames, ²Aviagen Ltd., Newbridge, United Kingdom.

Genomic selection will require use of small SNP panels to be cost effective. One approach is to genotype a training set using a high-density (HD) panel, and selection candidates with a subset of SNP forming an evenly-spaced low density (ELD) panel, then impute missing SNPs on a within-family basis. A key concern is the potential loss of accuracy, which we evaluated using ELD SNPs for body weight (BW) and hen house production (HHP) in a commercial broiler breeding line. The HD and ELD panels had 36,455 and 384 SNPs and were genotyped using Illumina Infinium and KASPar Kbioscience platforms, respectively. Training data included 1,091 HD genotyped individuals from 3 generations. The validation data included 168 progeny of training individuals that were both HD- and ELD-genotyped. A fast rule-based method was used to infer SNP haplotypes of training-set individuals. An overlapping-blocking Gibbs sampler was used to estimate joint probabilities of allele segregation indicators at adjacent ELD SNP for the validation individuals, utilizing also the haplotype information at ELD SNPs for training individuals. HD haplotypes in the training data and segregation probabilities at ELD SNPs for validation individuals were then used to estimate genotype probabilities of the missing HD SNPs in the validation individuals. Methods Bayes-A and -B ($\pi = 0.99$) were used to estimate marker effects in the training data to compute EBV of validation individuals, separately using either their observed or imputed HD genotypes. For the 168 validation individuals, the correlation between EBV from observed HD versus imputed HD genotypes was 0.973 and 0.967 for Bayes-B and Bayes-A for BWT, and 0.987 and 0.980 for Bayes-B and Bayes-A for HHP. These results demonstrate that use of ELD panels and imputing HD genotypes from training data can be a cost-effective approach to genomic selection, with limited loss in accuracy. Funding from Aviagen Ltd and SABRE Demonstration Funds of EU Framework 7.

Key Words: genomic selection, low-density marker panel, broiler chickens

31 Accuracy of genomic prediction using a threshold model to analyze categorical traits in purebred and crossbred beef cattle populations. K. Kizilkaya*^{1,2}, R. L. Fernando¹, and D. Garrick¹, ¹Iowa State University, Ames, ²Adnan Menderes University, Aydin, Turkey.

A simulation study was carried out to determine the accuracy of genomic prediction in purebred and crossbred beef cattle populations for categorical traits with heritabilities of 10% or 50%. The k observed Illumina 50K SNP genotypes from a purebred Angus training population were used to randomly select $(1-\pi)*k$ SNP to be QTL with $\pi = 0.999$. Underlying liabilities for 1,000 or 2,250 training animals were

simulated by adding fixed effects to normally distributed QTL and residual effects. Then, ordinal categorical data with 4 categories were generated by mapping liabilities to categories based on given fixed thresholds. Two- and 3-category ordinal data were created by combining categories in 4-category data. SNP effects excluding the QTL from 50K SNP genotypes were estimated applying Bayesian linear and threshold model averaging methods (Bayes-C) with a common variance for marker effects in the model. Accuracy of genomic prediction was estimated as the correlation between true and estimated genotypic values of animals in the validation data. Correlations were lower in the crossbred (0.149 to 0.487) than the purebred population (0.253 to 0.584), revealing that LD was not sufficient for genomic selection in this crossbred population. Low heritability and small size of the training population resulted in about 50% decrease in the accuracy for crossbred population; however, these differences tended to be smaller regardless of training population size for heritability of 50%. Four-category data provided higher accuracy than 2 and 3-category data. Accuracies of genomic prediction were found to be slightly different between threshold (0.403 to 0.508) and linear (0.390 to 0.487) Bayes-C models.

Key Words: genomic selection, threshold model, Bayes-C

32 Accuracy of genomic breeding values in Hereford beef cattle using k-means clustering method for cross-validation. M. Saatchi^{*1}, D. J. Garrick¹, and J. Ward², ¹Iowa State University, Ames, ²American Hereford Association, Kansas City, MO.

The objective of this study was to develop genomic breeding values (GBV) for 10 routinely recorded traits of Hereford beef cattle and quantify the corresponding accuracy of prediction. Eight hundred 5 animals were genotyped using the Illumina 50K SNP chip. Deregressed estimated progeny differences (EPDs) were used as observations in a weighted analysis to estimate marker effects to derive GBV. Genotyped individuals were clustered into 4 groups, randomly and using k-means method with the aim of increasing within-group and decreasing between-group relationships. Cross-validation was done 4 times using 3 groups for training and the other group for validation. Accuracy of GBV was obtained by standardizing the covariance between GBV and deregressed EPDs using the population genetic variance. Reported accuracies are the average of the 4-fold cross-validation and ranged from less than 0.2 for scrotal circumference, maternal and direct calving ease, from 0.2 to 0.4 for milk, fat, marbling, rib eye area and more than 0.4 for birth weight, weaning weight and yearling weight. Results showed that accuracies can be sensitive to the trait, the nature of the clustering, and the accuracies of deregressed EPDs in the validation cluster. The estimated marker effects show promise for routine use by Hereford breeders to predict genomic merit of their animals at a young age.

Key Words: genomic breeding values, cross-validation, k-means clustering, Hereford beef cattle

33 A genome-wide association study for perinatal suckling behavior in cattle. K. L. Parker,^{*} J. P. Cassady, and C. Maltecca, *North Carolina State University, Raleigh.*

The objective of this study was to identify chromosomal regions harboring quantitative trait loci affecting suckling ability in calves. In cattle, calves obtain immune competence passively through consumption of maternal colostrum. Permeability of calves' intestinal lumen

to colostral immunoglobulins drastically declines after the first 24 h of life, so that ensuring colostral consumption within this time frame is crucial. Brown Swiss calves often show weak perinatal suckling behavior leading to higher disease incidence and mortality. Data collected from the Italian Brown Swiss population, including records on 2,156 calves from 188 sires, were employed. For each calf, suckling ability was recorded as a categorical trait with 3 levels at 5 different times: 6, 12, 24, 48, and 72 h after birth. The behavior was recorded as 0 (drank without help), 1 (drank with help), or 2 (did not drink). To exploit familiar structure typical of dairy populations, sires of calves, rather than individuals themselves, were genotyped for 36,522 markers distributed across the 29 autosomes. BLUP estimates of breeding values for sires were obtained through a threshold liability model and utilized as "pseudo-phenotypes" in a GWAS analysis. A single marker regression was performed on the data to determine significant SNP markers. To ensure correct disentangling of familiar stratification, an extra polygenic effect was fitted to the model through the use of a genomic relationship matrix among sires. A critical value of $F = 11.2$ ($P < 0.001$) was used to determine marker significance. At this significance level, there were 1,257 significant markers distributed across all 29 autosomes with 7 highly significant areas. A second analysis employing 2 level hierarchical Bayesian LASSO modeling was performed to confirm and narrow areas of interest. There were 140 markers that showed significance in the LASSO analysis. Of the markers that were significant in the regression analysis, 9 also showed significance in the LASSO analysis on chromosomes 1, 3, 10, and 19.

Key Words: Brown Swiss cattle, genome-wide association, suckling behavior

34 Genetic parameters of feed efficiency indicators in crossbred steers. N. V. L. Serão,^{*} J. E. Beever, D. B. Faulkner, and S. L. Rodrigues-Zas, *University of Illinois, Urbana.*

The additive genetic contribution to the variation on multiple indicators and components of feed efficiency were assessed on a sample of 872 1/2 Simmental: 1/2 Angus steers. Phenotypes included average daily gain (ADG), dry matter intake (DMI), gain to feed (GF), residual feed intake (RFI), residual average daily gain (RADG), final weight (FW), carcass backfat (BF), rib-eye area (REA), marbling score (MARB) and calculated yield grade (CYG). The RADG included adjustments for DMI, BF, REA and mid-test metabolic weight, whereas RFI included adjustments for ADG, MARB, REA and mid-test metabolic weight. All models included the fixed effects of breed of sire (3 levels: Angus, Simmental and 1/2 Simmental: 1/2 Angus steers), diet (5 levels) and breed-by-diet interaction, and the random effects of contemporary group (farm-year combination, 12 levels) and sire nested with breed of sire (51 levels). Covariates included only on the relevant models included initial weight, hot carcass weight and harvest group. High heritability estimates ($h^2 > 0.40$) were associated with BF and MARB, whereas RFI, CYG and GF showed moderate estimates ($0.20 < h^2 < 0.40$) and DMI, REA, FW, RADG and ADG presented low heritabilities ($h^2 < 0.20$). Breed of sire-by-diet interaction had a significant association ($P < 0.05$) with most traits with the exception of DMI, BF, REA and CYG. The main effect of diet was significant for DMI and BF, meanwhile the main effect of breed of sire was significant for REA and CYG. Although RADG and ADG presented low heritabilities, the estimate from RADG is higher ($h^2 = 0.11$) than from ADG ($h^2 = 0.03$), suggesting that the adjustment of RADG reduced the noise of the trait and that selection for RADG would result in higher improvement of feed efficiency than selection for ADG. In a similar fashion, RFI was associated with a higher heritability estimate ($h^2 = 0.36$) than DMI (h^2

= 0.19). For the population studied, selection based on intake-based indicators is expected to result in superior genetic improvement for feed efficiency than selection based on gain-based indicators.

Key Words: residual feed intake, residual average daily gain, heritability, breed by diet

35 Imputation of single nucleotide polymorphism genotypes of Hereford cattle: Reference panel size and relationship. Y. Huang^{*1}, C. Maltecca¹, M. D. MacNeil², V. L. Leesburg², and J. P. Cassady¹, ¹North Carolina State University, Raleigh, ²USDA-ARS, Fort Keogh Livestock and Range Research Laboratory, Miles City, MT.

The objective of this study is to investigate single nucleotide polymorphism (SNP) genotypes imputation of Hereford cattle. Purebred Herefords were from 2 sources, Line 1 Hereford (n = 240) and representatives of Industry Herefords (n = 311). Using different reference panels of 62 to 494 males with 39503 SNPs on Bos Taurus autosomes, and a fixed study group of 57 Line 1 females for which genotypes were available for 10% of loci, imputation were performed to predict the other 90% loci. Imputation algorithm DAGPHASE (Tom Druet; Unit of Animal Genomics, University of Liège, Liège, Belgium) relies on linkage disequilibrium and linkage. Reference panels consisted of subsets or all males from Line 1 Hereford, Industry Hereford or both. Subsets from Industry Hereford were chosen randomly or based on relationship to study group using either pedigree derived family relationship or SNPs derived population structure. Average imputation accuracy went up when the size of reference panel increased. It reached a plateau when the ratio of reference panel size to study group size was larger than 4. The mean proportion of genotypes imputed correctly was 0.875 ± 0.041 when using reference panels from Line 1 Hereford, 0.769 ± 0.025 when using reference panels of random samples from Industry Hereford, 0.809 ± 0.006 when using highly related samples from Industry Hereford, 0.712 ± 0.029 when using lowly related samples from Industry Hereford. Highly related samples based on pedigree derived family relationship or SNPs derived population structure did not have significantly different imputation accuracies. Our study implied reference panel size and relationship can affect imputation accuracy.

Key Words: imputation, reference panel size, relationship

36 Differences in hair coat shedding, and effects on calf weaning weight and BCS among angus dams. K. A. Gray^{*1}, T. Smith², C. Maltecca¹, P. Overton¹, J. A. Parish², and J. P. Cassady¹, ¹North Carolina State University, Raleigh, ²Mississippi State University, Mississippi State.

The objective of the study was to assess variation in hair coat shedding of Angus cows, and its effect on adjusted weaning weight (d205wt) and BCS of the cow. Data were available from 532 Angus cows ranging in ages of 2–13 yr. Data were collected over a period of 3 yr in 2 different Southeastern states (MS, NC). Each year beginning in March and for 5 mo at 30-d intervals, trained technicians scored cows on a scale from 1 to 5, with 1 representing slick coats and 5 winter coats. For each cow, the first month with a score of 3 or less (MFS, 5 levels) was considered the beginning of winter coat shedding and used in the analyses. Association between MFS and d205WT or BCS, was investigated using the mixed procedure of SAS. Data were further analyzed by dividing cows into 2 groups, group one (Group 1) were cows with a shedding score of 3 or less by June 1st and group 2 (Group 2) consisted

of cows with a shedding score of 4 or 5 on June 1st (AS, 2 levels). Calves from Group 1 dams were 11.1 ± 2.8 kg heavier at weaning ($P < 0.01$) than calves from Group 2 dams. No significant differences were found between shedding score and BCS of the cow. Variance components were estimated using THRGIBBS1F90 and heritability of AS was calculated ($h^2 = 0.35$) with a moderate genetic correlation with D205WT ($r_g = -0.58$). Hair coat shedding is a heritable trait and could be altered by selection. Producers within the Southeastern or Southern United States who are concerned about heat stress may want to select for cattle that shed their winter hair coat earlier in the season. In conclusion, cows that shed their winter coat by June 1st will wean heavier calves on average.

Key Words: hair coat shedding, BCS, weaning weight, beef cattle

37 Effects of dietary aflatoxin on hepatic gene expression in swine. S. M. Rustemeyer¹, W. R. Lamberson², D. R. Ledoux², K. Wells², K. J. Austin¹, and K. M. Cammack^{*1}, ¹University of Wyoming, Laramie, ²University of Missouri, Columbia.

Aflatoxin B₁ (AFB₁) concentration can be high in commonly used feedstuffs and lead to an increased incidence of aflatoxicosis, a disease associated with decreased feed intake, reduced BW gain, and impaired liver function in monogastric livestock. The objective of this study was to determine the effects of AFB₁ on performance and hepatic gene expression of growing barrows. Duroc x Yorkshire crossbred barrows (n = 90; age = 35 ± 5 d; initial BW = 14.2 ± 3.0 kg) were randomly assigned in a 3×3 factorial design to receive 0 (CON), 250 ppb AFB₁ (LOW) or 500 ppb AFB₁ (HIGH) for 7, 28 or 70 d, after which barrows were killed and liver samples collected. RNA-Sequencing was performed on liver samples collected on d 70 to detect changes in hepatic gene expression associated with declines in performance. Of 82,744 total transcripts probed, 179 had copy numbers highly correlated ($r \geq |0.80|$; $P < 0.01$) with treatment; 46 were downregulated in AFB₁-treated barrows, and 133 transcripts were upregulated. Annotation of transcripts with human genomic information indicated functions of apoptosis, regulation of cell growth, and mRNA processing. Genes in the apoptosis category were the most prevalent; 15 genes were specific to apoptosis regulation. Expression of the 2 most upregulated and the 2 most downregulated apoptosis regulating genes was confirmed with semiquantitative PCR, indicating that RNA sequencing can be used to assess changes in gene expression. Semiquantitative PCR also showed that 4 of the 15 apoptosis regulating genes were also differentially expressed in d 7 tissues, suggesting those genes may be early indicators of aflatoxicosis. These results suggest that administration of an AFB₁ contaminated diet can alter both early and chronic hepatic gene expression.

Key Words: aflatoxin, gene expression, sequencing, swine

38 Heritability of hepatic expression of apoptosis genes affected in pigs fed aflatoxin B₁. K. S. Roberts^{*1}, S. M. Rustemeyer², M. M. Rolf¹, K. M. Cammack², and W. R. Lamberson¹, ¹University of Missouri, Columbia, ²University of Wyoming, Laramie.

Variation in gene expression may be a link between genotype determining phenotype in economically important traits in livestock. Development of techniques to measure expression of large numbers of genes provides an opportunity to evaluate gene expression as a phenotype and thus estimate the genetic contribution to variation. The initial objective of this study was to estimate the heritability of expres-

sion of 15 genes functioning in apoptosis and significantly affected by aflatoxin in 23 growing barrows fed 0, 250 or 500 ppb aflatoxin B₁ from 35 to 105 d of age. Pigs were killed on the last day of aflatoxin feeding, liver samples were collected, snap-frozen on dry-ice, and stored at -80°C until total RNA was isolated and gene expression was measured by using RNA-Sequencing. Pigs used in the study were non-littermate Duroc x Yorkshire barrows without recorded pedigrees. Relationships were estimated by evaluating similarity of 15,716 SNP genotypes of the experimental animals. Pigs with similar genotypes were considered closely related and assigned the same sire. Heritabilities were estimated by fitting gene expression values to a model including the fixed effect of treatment and random effect of sire and multiplying the ratio of sire to total variance by 4. Heritability was zero in 14 of 15 apoptosis genes. We hypothesize that variation associated with response to aflatoxin treatment masked the effect of sire for these genes. The heritability of expression of the apoptosis gene PIM1 was 0.03. Heritability of expression was subsequently estimated for 20 genes randomly selected with respect to function, but not affected by aflatoxin treatment. Of the 20 genes not related to apoptosis, heritability of expression was positive for 12. The heritability of expression for these 12 genes averaged 0.23 and ranged from 0.03 to 0.51. These results demonstrate that heritability of gene expression falls within expected ranges, but may differ depending on the function of gene.

Key Words: pig, heritability, gene expression, RNA-sequencing

39 Genetic and phenotypic correlations for maternal and post-weaning traits from a commercial swine breeding system. C. E. Abell,* K. J. Stalder, and J. W. Mabry, Iowa State University, Ames.

The purpose of this study was to determine the genetic and phenotypic correlation between maternal and post-weaning traits from a seedstock swine breeding system. Determining the genetic correlations among traits can help breeders evaluate the expected affects on other economically important production traits that are not included in the selection criteria. This is particularly important when considering maternal and post-weaning traits because of the undesirable genetic correlations that typically exist between maternal and post-weaning traits. When selection is based solely on maternal traits, post-weaning traits often suffer. This makes it difficult to improve both traits at the same time. Records on 7,015 sows were used in this study. The sows were born between the years 1992 and 2009. The traits considered were number born alive (NBA), annualized farrowing interval (AFI), adjusted back fat (BF), percent lean (PCL), and days to 100 kg (D100). Post-weaning traits were measured on those gilts that could potentially be selected to enter the breeding herd. Post-weaning trait means were 60.4%, 9.9 mm, and 164 d for PCL, BF, D100, respectively. Maternal traits were measured on all sows in the breeding herd. Maternal trait means were 2.41 and 11.4 for AFI and NBA, respectively. The heritabilities for the traits were 0.17 for NBA, 0.04 for AFI, 0.48 for BF, 0.56 for PCL, and 0.61 for D100. The strongest phenotypic correlation was between PCL and BF at -0.72 ($P < 0.05$). The genetic correlations between AFI and each of the post-weaning traits (BF, PCL, and D100) were 0.41, -0.53, and 0.49 ($P < 0.05$), respectively. The genetic correlations between NBA and the post-weaning traits were small and not directionally conclusive. These results suggest that selecting for a greater AFI may have an unfavorable result on economically important post-weaning production traits unless these genetic correlations were taken into consideration.

Key Words: genetic correlation, phenotypic correlation, heritability, swine

Breeding and Genetics: The Genetics of Disease Resistance Symposium

40 (Invited) Exploring the genetics of vaccine response in cattle. M. Gonda,* South Dakota State University, Brookings.

Research to discover quantitative trait loci (QTL) associated with bovine health traits has primarily focused on a qualitative phenotype: either an animal is “infected” or “uninfected.” An alternative, complementary approach to improving the genetics of health traits is to select for animals that develop a strong immune response to vaccination. Instead of attempting to design better vaccines that improve protection for a larger proportion of a population, can we also select for cattle that develop a more protective immune response to currently available vaccines? In feedlots, mortality and morbidity caused by BVDV was estimated to cost the US beef industry about \$90 to \$95 per animal. Our laboratory is investigating the genetics of Bovine Viral Diarrhea Virus (BVDV) vaccine response in cattle. We have focused on 2 measures of the humoral immune response to BVDV vaccination: 1) Enzyme-linked immunosorbent assay (ELISA) and 2) Serum neutralization (SN). The SN is functionally more relevant for measuring

vaccine response because SN detects only antibodies that neutralize the virus. However, the ELISA is cheaper and subject to less intra- and inter-laboratory variation than SN. To test whether the ELISA could be used as an indicator trait for measuring a protective immune response, we compared BVDV antibody levels detected by 1) a commercially available ELISA, 2) SN Type 1, and 3) SN Type 2 in blood samples collected from Angus and Angus cross calves ($n = 406$). The BVDV-specific antibodies measured by the ELISA were correlated with BVDV protective antibodies measured by SN Type 1 ($\rho = 0.809$) and SN Type 2 ($\rho = 0.638$) ($P < 0.0001$). Using this ELISA, we found that sire of the calf was associated with BVDV vaccine response in 267 Angus and Angus cross calves ($P < 0.05$), suggesting that this trait is heritable. This result is in agreement with other studies that have found vaccine response to be heritable in cattle and humans. A strategy to reduce BVDV incidence may be to select for animals that respond more strongly to vaccination.

Key Words: vaccine response, genetics, BVDV, beef cattle

41 (Invited) Genomics of susceptibility of dairy cattle to infection by *Mycobacterium avium* ssp. *paratuberculosis*. B. W. Kirkpatrick,* X. Shi, G. E. Shook, and M. T. Collins, *University of Wisconsin, Madison*.

The objective of these studies was to identify genetic markers and genomic regions associated with susceptibility to *Mycobacterium avium* ssp. *paratuberculosis* (MAP) infection in Holstein cattle. Associated SNPs were identified by genotyping 521 MAP-infected Holstein cows and comparing SNP allele frequencies of these infected cows with allele frequencies estimated from specific reference populations. Reference population allele frequency estimates used Holstein sire genotype data and were weighted estimates based on sire usage within the population in question. The 521 infected cows were 233 and 288 cows from 2 resource populations of approximately 5,000 cows each, collected independently. Population 1 was comprised primarily of daughters of 12 Holstein artificial insemination sires used heavily within the US dairy cattle population. Samples were obtained from 300 cooperating commercial dairy herds throughout the US and were tested by both MAP fecal culture and blood-ELISA. Population 2 consisted of dairy cattle from 6 cooperating dairy herds in Wisconsin, with all animals in the herds tested by blood-ELISA for MAP infection. Genotyping was performed with the Illumina Bovine SNP50 Bead Chip, providing genotypes for 35,772 informative SNPs. Data from the 2 resource populations were analyzed both in separate and combined analyses. The most significant autosomal markers from the individual and combined analyses (nominal $P < 0.001$) were used in a stepwise logistic regression analysis to identify a reduced set of SNPs that could be used as a predictor of genetics for Holstein cattle susceptibility to MAP infection.

Key Words: cattle, cow, paratuberculosis, SNP

42 (Invited) Genetic dissection of disease susceptibility in swine. D. Ciobanu* and R. Johnson, *University of Nebraska, Lincoln*.

Genetic variation for disease resistance is a result of quantitative and qualitative changes in expression of genes that regulate innate and adaptive immune responses. Recently, our research has shown evidence of genetic variance of the host associated with differences in the susceptibility to PRRSV and PCVAD. Hampshire x Duroc cross-breeds pigs experimentally infected with PRRSV gained less weight, had higher rectal temperature, viral loads, antibody titer, and incidence of lung lesions compared with Nebraska Index Line. High pre-inoculation levels of interleukin 8 and low post-inoculation levels of interferon gamma were significantly associated with potential resistance to PRRSV infection.

Evidence of significant variation in the magnitude and time of immune response was demonstrated in experimental challenges with PCV2b. Individuals displaying early or no immune response were less affected by inoculation. The lack of immune response was associated with reduced viremia, most likely due to a mechanism that inhibits virus replication. Genetic analysis of PCVAD susceptibility revealed moderate to high heritabilities for viremia (0.38) and IgG (0.55) in 90d old pigs naturally infected with PCV2. Viral load significantly impacted growth in natural and experimental challenges with PCV2. In natural PCV2 infection, viremia was highly genetically correlated with a PCVAD score ($rG = 0.75$) that incorporates degree of muscle wasting, growth retardation, rough hair coat, diarrhea, and respiratory distress. The phenotypic correlation between viral load and average daily gain during 4 weeks of experimental challenge with a PCV2b strain was -0.29 . The goal of our research is to establish an extensive set of sam-

ples and phenotypes for genomics studies to understand and dissect genetic factors associated with variation in disease susceptibility, and then to use that information in breeding programs to improve genetic resistance and overall fitness of swine populations.

Key Words: pig, genetics, disease resistance, PRRSV PCV2

43 (Invited) Genomics of bovine respiratory disease complex at USMARC. L. A. Kuehn,* E. Casas, G. L. Bennett, C. G. Chitko-McKown, J. W. Keele, T. G. McDanel, W. M. Snelling, and R. M. Thallman, *USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE*.

Selection for genetic resistance/resilience bovine respiratory disease complex (BRDC) would significantly increase the efficiency of beef production in the US through decreased treatment costs, morbidity, and death loss. Unfortunately, selection for resistance to BRDC is challenging to implement for multiple reasons: treatment records are not absolute (sick animals undiagnosed, healthy animals treated, etc.), multiple pathogens cause the same complex, exposure to pathogens is inconsistent, and records generally do not exist for breeding animals to apply standard genetic evaluation approaches. Genetic markers are an alternative to traditional selection, but detection requires large phenotypic databases. The US Meat Animal Research Center (USMARC) has implemented a multi-faceted approach to implement discovery of genetic markers associated with resistance to BRDC. Regions of interest were identified using treatment records from steers in a genome wide association study using the Illumina BovineSNP50. These results have been used in fine mapping studies to identify markers on BTA 1, 2, 6, 20, and 26. A subset ($n = 2,200$ as of 2010) of the USMARC germplasm evaluation program has been dedicated to collecting indicative phenotypes for risk of acquiring BRDC (vaccination response, stress indicators) and for undiagnosed infections (lung lesions at slaughter, complete blood counts, pathogen identification at treatment). Last, DNA pooling strategies (pools of high vs. low disease incidence) have been employed as a tool to detect marker frequency differences in large samples. This strategy has been applied for detecting resistance to BRDC on large portions of USMARC treated animals and on industry animals of unknown origin based on lung lesion differences at slaughter or treatment records at cooperating feedlots. The combination of fine mapping, extensive phenotyping, and larger data sets will support discovery of genomic tools useful for selection.

Key Words: bovine respiratory disease complex, cattle, genetics

44 PRRS host genetics consortium: Background and current progress. J. K. Lunney*¹, N. Boddicker², J. C. M. Dekkers², D. J. Garrick², S. Abrams¹, J. P. Steibel³, J. M. Reecy², E. Fritz², M. Rothschild², M. Kerrigan⁴, B. Tribble⁴, and R. R. Rowland⁴, ¹USDA, ARS, BARC APDL, Beltsville, MD, ²Iowa State University, Department of Animal Science, Ames, ³Michigan State University, Department of Animal Science, Fisheries and Wildlife, East Lansing, ⁴Kansas State University, Department Diagnostic Medicine and Pathobiology, Manhattan.

Porcine reproductive and respiratory syndrome virus (PRRSV) is the most important infectious disease threat to pig production worldwide. The limited protection provided by vaccines make it essential to identify factors involved in PRRS resistance. The PRRS Host Genetics Consortium (PHGC) was established to determine the role of host genetics in PRRS resistance and related growth effects. The PHGC nursery pig model has tested responses of 8 groups of 200 commercial crossbred pigs to infection with one PRRSV isolate. Pigs were followed for 42 d post infection (dpi) collecting blood serum and Tempus (RNA) sam-

ples with weekly recording of weights to derive weight gain (WG). All pigs became PRRSV infected with peak viremia from 4 to 21 dpi. Sera samples were used to derive a single measure of infection based on the area under the curve (viral AUC). Genomic DNA was genotyped with the Porcine SNP60 SNPchip for genome wide association studies. Heritabilities for viral AUC and WG were 0.31 and 0.19 based on the sire variance, while the dam component indicated substantial maternal or litter effects. Associations with SNPs were identified using the method Bayes-C-pi of the Gensel software. Using *Sus scrofa* build 10,

regions on chromosomes 1, 4, 5, 11, and 16 were found to be associated with viral AUC and regions on chromosomes 1, 4, 7, and 17 with WG. Bivariate statistical analyses of viral AUC and WG have clustered pigs into virus/weight categories for further research to identify biomarkers that distinguish PRRS resistant/maximal growth pigs from PRRS susceptible/reduced growth pigs. The PHGC is funded by the US National Pork Board, USDA ARS, USDA NIFA PRRS CAP and functional genomic grants, NRSP8 Swine Genome and Bioinformatics Coordination programs, and private companies.

Monday, March 14, 2011

SYMPOSIA AND ORAL SESSIONS

David H. Baker Symposium—Invited Papers Only: Amino Acid Symposium

45 (Invited) Nitrogen-containing nutrients and the developing infant. P. Anderson,* *Abbott Nutrition, Columbus, OH.*

The primary nitrogenous sources that fulfill the amino acid requirements of the growing infant are casein and whey proteins, such as lactoferrin. Early research demonstrated that other nitrogen containing nutrients in breast milk, such as taurine and carnitine, are conditionally essential for infants. In fact almost every amino acid classified as nonessential in adults has at some time been proposed as conditionally essential in preterm or term infants. More recently the focus has turned to nucleotides, small compounds of low molecular weight that represent up to 20% of the non-protein nitrogen in human milk, and human milk oligosaccharides, the third most predominant component in human milk behind only lactose and fat, and more than contributed by protein. The concentration and diversity of oligosaccharides in human milk is remarkable when compared with all other species. These oligosaccharides, containing lactose or galactose and glucose, also can have N-containing building blocks, such as lacto-N-neotetraose, consisting of lactose bound to N-acetylglucosamine or sialic acid (N-acetylneuraminic acid). Sialic acid itself is a structural and functional component of brain gangliosides and could play a role in neurotransmission and memory. But the major functions of the human milk oligosaccharides have been classified by their role in promoting gastrointestinal maturation and cell adhesion, anti-adhesion and anti-infectivity by reducing attachment of pathogens to the intestinal lining, and stimulation of innate immunity. There is good evidence that the oligosaccharides pass through the gastrointestinal tract to the colon where they have a growth promoting role on healthy microbiota. Recent research has also demonstrated that even whey proteins can undergo various degrees of glycosylation depending on the stage of lactation, a physiological change which may be important for the infants developing intestinal tract and immune system.

Key Words: infant, milk, oligosaccharides, nitrogen

46 (Invited) Utilization of threonine by non-ruminant animals. O. Adeola,* *Purdue University, West Lafayette, IN.*

Dietary amino acids released during digestion are absorbed and utilized for a variety of body functions. Efficiency with which these amino acids are used in the body depends on several factors. Based on the dietary needs to maintain zero nitrogen balance and/or growth, threonine is classified as a nutritionally indispensable amino acid for non-ruminant animals. The use of threonine for maintenance and production therefore involves utilization in protein synthesis for incorporation into tissue proteins. In addition, threonine is used for the synthesis of the mucin protein, which is required for maintaining intestinal integrity and function, protein phosphorylation and glycosylation, for immune function, and for glycine synthesis. Digest-

ibility of threonine in feed ingredients used in formulating feeds for non-ruminant animals is variable, running between 55 and 75%, and is usually lower than for other indispensable amino acids, due in part to endogenous intestinal losses of threonine. Also, the efficiency of utilizing threonine for deposition in the body is, in most cases, lower than for other indispensable amino acids. Dietary components such as type and amount of non-starch polysaccharides affect the efficiency of dietary threonine use for protein deposition. It has been shown that greater than 50% of dietary threonine is extracted in first-pass metabolism by the portal-drained visceral, with 30% of the extracted threonine being catabolized by the small intestine. Furthermore, threonine plays a crucial role in the protein backbone of the mucin, which is a major component that is necessary for integrity of the mucus layer. Intestinal mucin dynamics may be particularly sensitive to threonine deficiency due to the high concentration and structural importance of threonine in the mucin molecule. Recent results indicate that restriction of dietary threonine impairs intestinal mucin synthesis and show that a link exists between threonine deficiency and crude mucin excretion. Situations associated with reduced intestinal availability of threonine may decrease intestinal mucin synthesis and consequently reduce intestinal protective functions and nutrient digestibility.

Key Words: digestibility, mucin, threonine, utilization

47 Amino acid digestibility and concentration of digestible and metabolizable energy in a threonine co-product fed to weanling pigs. F. N. Almeida,* R. C. Sulabo, and H. H. Stein, *University of Illinois, Urbana.*

Production of crystalline Thr results in generation of a Thr co-product (TCP) that contains more than 80% CP, 5.20% Lys, 5.10% Val, 4.50% Thr, 4.15% Ile, and 1.06% Trp. It is possible that TCP can be used as a feed ingredient in diets fed to weanling pigs, but there is limited information about the nutritional value of TCP. It was, therefore, the objective of this work to determine the AA digestibility and energy concentration in TCP. The apparent (AID) and the standardized (SID) ileal digestibility of CP and AA were measured in Exp. 1. Nine pigs (initial BW: 13.4 ± 2.5 kg) were equipped with a T-cannula in the distal ileum and allotted to a triplicated 3 × 3 Latin square design with 3 diets and 3 periods in each square. One diet contained 20% TCP as the sole source of AA and a second diet contained 25% fish meal (FM) as the sole source of AA. The last diet was a N-free diet that was used to measure basal endogenous losses of AA and CP. Results indicated that the AID and SID of all indispensable AA except Trp were greater ($P < 0.05$) in TCP than in FM. The AID of all dispensable AA except Gly, Pro, and Tau and the SID of all dispensable AA except Pro and Tau were also greater ($P < 0.05$) in TCP than in FM. In Exp. 2, 20 4 pigs (initial BW: 18.0 ± 3.5 kg) were placed in metabolism cages and randomly allotted to 3 diets. The first diet contained 96.4% corn, the

second diet contained 79.3% corn and 17.0% TCP, and the third diet contained 75.3% corn and 24.0% FM. Total collection of feces and urine was performed for 5 d after a 5 d adaptation period. The DE in TCP was greater ($P < 0.01$) than in FM and corn (4,935, 4,699, and 3,939 kcal DE/kg DM, respectively). The ME in TCP and FM (4,084 and 4,319 kcal ME/kg DM, respectively) were not different, but both values were greater ($P < 0.01$) than the ME in corn (3,812 kcal/kg DM). Results from these experiments indicate that TCP is an excellent source of AA and ME. It is, therefore, possible that TCP can replace FM in diets fed to weanling pigs.

Key Words: amino acids, digestibility, energy, threonine co-product

48 (Invited) Exogenous enzymes and amino acid digestibility. A. J. Cowieson,* *University of Sydney, Australia.*

Since the first reports in the early 1990s there have been approximately 45 independent, peer-reviewed manuscripts that have reported the effect of exogenous enzymes on ileal amino acid digestibility in pigs and poultry. This data set comprises approximately half pig and half poultry, about half wheat and the rest corn, sorghum, barley or rye, a mixture of locations, principally US, Europe, New Zealand and Australia and about half include carbohydrase (principally xylanase), with the rest being phytase. The mean improvement in ileal amino acid digestibility associated with carbohydrase addition is 4.8% and the responses are generally higher in wheat-based rather than corn-based diets (4.5% vs. 3.5%). Interestingly the mean response in poultry and swine is similar (4.8% in poultry and 5.2% in swine). For phytase the mean improvement in ileal amino acid digestibility is around 3% but the responses are greater for poultry than pigs (approx. 4–5% vs. 1–2%). Pivotal, for both phytase and carbohydrase, the magnitude of response is particularly dictated by the inherent digestibility of amino acids in the control diet such that for every 10% improvement in inherent digestibility the response to the supplemental enzyme is eroded by 50%. For example, where inherent digestibility is 80% the average response to carbohydrase and phytase would be around 5% and 4%, respectively, but at 90% inherent digestibility this drops to 2.5% and 2%, respectively. It is of some importance that the response to a supplemental enzyme is influenced by the inherent digestibility of the diet to which the enzyme will be added. This fact may explain why responses are generally lower in corn vs. wheat-based diets and perhaps why there appears to be a lower response when CrO₂ is used as an indigestible marker vs. TiO₂. Importantly, the fact that responses decay with improving 'control' digestibility precludes the possibility of full additivity of effect when combining supplemental enzymes. The premise is that only the first enzyme of choice may carry its full matrix value with subsequent enzymes having their value reduced based on the new improved diet. In conclusion, supplemental enzymes improve ileal amino acid digestibility and this is fairly predictable and follows a consistent pattern based on inherent digestibility.

Key Words: xylanase, phytase, amino acid

49 Effect of a multi-carbohydrase enzyme on apparent and standardized ileal amino acid digestibility in extruded full fat soybeans fed to finishing pigs. D. Ayoade,* E. Kiarie, B. Slominski, and C. M. Nyachoti, *University of Manitoba, Winnipeg, MB, Canada.*

Extrusion technology has been employed successfully to improve the nutritive value of full fat seeds via deactivation of the anti-nutritive factors. However, the fibrous portion of the seeds is largely intact

following extrusion and application of enzymes targeting non-starch polysaccharides of the fiber fraction might improve the nutritive value of full fat seeds further. This notion was investigated in a study involving 6-ileal cannulated barrows (average initial BW = 75.0Kg) fed extruded full fat soybean (FFSB) without or with a multi-carbohydrase enzyme (CE) to determine apparent ileal digestibility (AID) of energy and standardized ileal digestibility (SID) of AA. The CE supplement provided 500 units pectinase, 50 units cellulase, 400 units mannanase, 1,200 units xylanase, 450 units glucanase and 45 units galactanase per Kg of diet. A basal diet was formulated to contain FFSB as the sole source of AA; the CE diet was made by supplementing the basal diet with CE. All diets had titanium oxide as an indigestible marker. Diets were fed in a 2-period crossover design to give 6 observations per diet. Each experimental period lasted 7d; 5d adaptation period and 2d ileal digesta collection. The SID of N and AA were calculated using published values from our laboratory. CE supplementation increased ($P < 0.01$) the AID values of DM (69 vs. 66%), GE (75 vs. 71%) and N (64 vs. 58%). The CE supplemented diet had higher ($P < 0.05$) AID values for Leu, Lys, Met+Cys, Thr, Cys, Ser and Tyr than the basal diet. Compared with the basal diet, the CE supplemented diet had higher ($P < 0.01$) SID value for N (74 vs. 69%) and higher ($P < 0.05$) SID values for Lys (73 vs. 69%), Met (63 vs. 57%), Met+Cys (60 vs. 52%) and Thr (66 vs. 61%). The average SID for indispensable and total AA increased ($P < 0.1$) by 3 and 4 percentage units respectively. In conclusion, CE supplementation increased the nutritive value of extruded FFSB for finishing pigs.

Key Words: extruded full fat soybean, multi-carbohydrase enzyme supplementation, pigs

50 (Invited) Amino acid requirements of modern sows. R. O. Ball,* *University of Alberta, Edmonton, AB, Canada.*

Nutrition of sows has received little attention compared with growing-finishing pigs despite the fact that sows consume approximately 20% of the feed consumed by all pigs. Therefore, improving sow nutrition offers the opportunity for substantial savings in feed cost. We recently measured lysine and threonine requirements of sows at maintenance, and gestating sows in early and late pregnancy. We found for threonine that in early gestation (d 35 to 53) sows required 6.1 to 7.2 g/d and during late gestation (d 92 to 110) required 13.6 to 14.0 g/d. Our estimates for early gestation are markedly lower than NRC (1998). However, the threonine intake required for maximum protein synthesis in late gestation is more than double that required during early gestation, and exceeds the recommendation of NRC (1998) by far. We have found similar results for lysine. Current NRC recommendations are not appropriate for the highly productive sow of today. Phase feeding, using separate diets for early/mid gestation and late gestation should save feed cost and may produce better and more uniform litters and may increase sow longevity. Research is currently underway on tryptophan and isoleucine requirements. This presentation will review recent research in sow nutrition, suggest feeding strategies for sows, and their impact on feed cost, and suggest future research opportunities.

51 Influence of dietary L-arginine supplementation to sows during late gestation on sow and litter performance during lactation. B. E. Bass*¹, C. L. Bradley¹, Z. B. Johnson¹, C. V. Maxwell¹, R. D. Boyd², J. L. Usry³, and J. W. Frank¹, ¹*University of Arkansas, Fayetteville,* ²*The Hanor Company, Franklin, KY,* ³*Ajinomoto Heartland, LLC, Chicago, IL.*

Ninety-nine gilts and sows (PIC GPK35) were used in this study to evaluate the effects of feeding 1% L-arginine during the final 3 wk of gestation on sow and litter performance. Sows were allotted to one of 2 dietary treatments, a control diet with no additional L-arginine (CON), or a diet providing an additional 25 g/d arginine (ARG), based on parity (0, 1, or 2+) and weight at the initiation of the study (d 93 gestation). From d 93 of gestation to farrowing, animals were provided 2.72 kg feed/d containing 0.63% SID Lysine in 2 equal meals. On d 110, animals were weighed and moved into farrowing. A common lactation diet was provided upon farrowing. Sows were additionally weighed 48 h post-farrowing and at weaning. Late gestational BW gain (d 93 to 110), farrowing (d 110 to 48 h post-farrowing) and lactation BW loss (d 110 to weaning) were calculated. Sow and litter performance data, including number born alive, number weaned, individual birth and weaning weights, and placenta weight, were recorded. Plasma samples were collected on d 93 and 110 and IGF-1, insulin, and BUN levels

analyzed. There was a tendency for a greater late gestation BW gain ($P = 0.06$) in ARG compared with CON (14.4 and 12.0 kg, respectively). Additionally, a tendency for a parity by treatment interaction was observed for late gestation BW gain with parity 1 ARG gaining the most, and parity 0 ARG intermediate to all other treatments ($P = 0.1$). There were no differences between treatment groups observed in farrowing or lactation BW loss, number born alive, number weaned, birth weight, weaning weight, or placenta weight ($P > 0.05$). Additionally, there were no differences between CON and ARG gilts and sows for plasma IGF-1, insulin, or BUN concentration at d 93 or 110 of gestation ($P > 0.05$). In conclusion, late gestational supplementation with L-arginine may be beneficial to sow BW gain, independent of litter and placental weight, but had no effect on litter size or lactation performance.

Key Words: sow, arginine

Tuesday, March 15, 2011

SYMPOSIA AND ORAL SESSIONS

Extension—Beef/Small Ruminant Symposium: Beef Cattle Reproduction Management NCERA-087 Beef Cow-Calf Nutrition and Management

52 (Invited) Impact of bull development on reproductive success. G. A. Perry*¹, G. P. Rupp², and R. A. Cushman³, ¹South Dakota State University, Brookings, ²University of Nebraska, GPVEC, Clay Center, ³USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.

The herd bull influences overall herd fertility more than any other single animal. However, a bull must be developed properly and have reached puberty to be fertile. Puberty is defined by an ejaculate containing a minimum of 50×10^6 total sperm with at least 10% progressive motility; however, this is not sufficient to pass a Breeding Soundness Exam (BSE). Simply because a bull can produce semen does not mean he is fertile. Sperm quality and quantity continued to increase for months after the initiation of production, and morphology has been reported to positively influence pregnancy success. High levels of energy can increase wt, height, and scrotal circumference (SC) without affecting age at puberty or first mating. Birth wt, weaning wt, weaning hip height, weaning hip to wt ratio, birth to weaning ADG, yr wt, yr hip height, yr hip to wt ratio, weaning to yr ADG, % of BW gained from weaning to yr, sperm motility, sperm morphology, and pass/fail BSE have been collected on 1940, 13 to 20 mo old bulls in South Dakota. Analysis of the data indicated that age at time of BSE had the largest impact on motility ($r^2 = 0.06$; $P < 0.001$), morphology ($r^2 = 0.03$; $P < 0.001$), and ability to pass a BSE ($r^2 = 0.03$; $P < 0.001$). Inclusion of all variables only accounted for 10%, 9.5%, and 9.7% of the variation in motility, morphology, and ability to pass a BSE, respectively. Analysis of 259 BSE performed at USMARC also showed a significant increase in SC as age increased from 15 to 20 mo of age. While analysis of over 3800 BSE performed at USMARC on bulls from 12 to 98 mo of age showed a positive correlation between SC and both motility ($r^2 = 0.11$; $P < 0.0001$) and morphology ($r^2 = 0.07$; $P < 0.0001$). In summary, development of herd bulls can impact the reproductive performance of an entire herd, and while supplying proper nutrition is important to proper development, getting bulls over conditioned can have a negative impact on semen quality. However, the factors that have a large impact on semen quality are largely unknown.

Key Words: bull development, fertility, semen

53 (Invited) Impact of heifer development on reproductive success. D. J. Patterson,* *University of Missouri, Columbia.*

Reproductive success and the future productivity of a beef herd hinges on the selection and management of future replacements. Reproductive competence is established as a consequence of a specific program of developmental events leading to organization of functionally competent reproductive tissues and organs. The timing of puberty is critical in determining whether a heifer remains in the herd and the extent to which lifetime productivity is achieved. Producers should assume that

the majority of factors related to reproductive performance in cattle are influenced almost entirely by management because most components of fertility that influence calving and subsequent reproductive performance are not highly heritable. Management of replacement females should encompass a broad range of considerations including the age of the heifer, breed type or genetic make-up, nutrition and health, a prebreeding assessment of reproductive status, choice of an estrous synchronization protocol, and breeding strategies that include criteria related to the selection of service sires. Collectively, these decisions will impact breeding performance of heifers during the first breeding season and during their subsequent calving and rebreeding period as 2-yr-olds. The intended purpose of this review is to focus on those practices that will ensure that heifers entering the herd as raised or purchased replacements will contribute to the general performance and productivity of the entire cow herd immediately, and cumulatively long-term.

Key Words: beef heifer, reproduction, management, puberty

54 (Invited) The 5 day CO-Synch + CIDR Protocol for facilitating timed-AI in cattle. G. A. Bridges*¹, P. J. Gunn², and M. L. Day³, ¹University of Minnesota, Grand Rapids, ²Purdue University, West Lafayette, IN, ³The Ohio State University, Columbus.

The most widely utilized method for facilitating timed-AI in beef cattle is the CO-Synch approach. This approach uses GnRH and PGF_{2 α} (PGF) to sequentially control ovarian follicular dynamics, luteolysis, the length of proestrus (interval from PGF to GnRH) and ovulation. The CO-Synch approach was originally designed to have 7 d between GnRH and PGF administration and often a CIDR was included. Following a series of studies at The Ohio State University that suggested increasing the interval of proestrus and subsequently preovulatory estradiol concentrations would enhance fertility; we hypothesized that if the interval between GnRH and PGF in the CO-Synch approach was reduced to 5 d, proestrus could be extended to allow for increased preovulatory estradiol and improved timed-AI pregnancy rates. Thus the 5 d CO-Synch + CIDR protocol was developed with GnRH administration and CIDR insertion on d 0, PGF administration and CIDR removal on d 5, and timed-AI occurring concurrent with GnRH 72 h after CIDR removal on d 8. Since the interval from GnRH to PGF is 5 d, 2 doses of PGF (25 mg/dose) or its analog, cloprostenol sodium (500 μ g/dose), spaced at 6 to 10 h apart are administered to ensure luteolysis. Subsequent research has demonstrated that the 5 d CO-Synch + CIDR protocol increased timed-AI pregnancy rates in both lactating beef cows and heifers compared with the 7 d CO-Synch approach. Research with the 5 d protocol over the past 5 yr in Ohio, Indiana, Virginia, and Colorado (3,606 cows from 39 herds) resulted in timed-AI pregnancy rates of 61% and demonstrated that the protocol works effectively in both primiparous and multiparous cows as

well as cyclic and anestrous females. Current research is focused on the appropriate interval for delivery of PGF in an attempt to decrease the number of animal handlings required. Additionally, research in lactating dairy cows and dairy heifers has demonstrated that the 5 d CO-Synch approach is a viable alternative for facilitating timed-AI in these females. In conclusion, the 5 d CO-Synch + CIDR program is an effective estrous synchronization program to facilitate timed-AI in all classes of female cattle.

Key Words: 5 d CO-Synch + CIDR, timed-AI, beef, dairy

55 (Invited) Impact and limitations of sire fertility estimates and sex-sorted semen on the success of dairy and beef AI programs. J. M. DeJarnette,* *Select Sires, Inc., Plain City, OH.*

Facilitated by centralized record reporting and analysis by dairy herd improvement organizations, the technology of artificial insemination (AI) was readily adopted by the dairy industry for the genetic improvement of cattle. Systems to monitor sire fertility were promptly implemented as technician non-return rate evaluations and later evolved into more sophisticated models to evaluate on-farm conception rates. Even though the precision of sire fertility estimates are limited as a function of confounding environmental factors and binomial variation,

these systems have been used by dairy producers and AI center personnel to select (cull) sires based on fertility potential for more than 60 years. Presently, ~90% of all dairy sires (proven and unproven young sires combined) achieve conception rates within $\pm 3\%$ range of average fertility. Although fertility estimates are commonly used to select above average fertility sires for use in fixed-time AI programs, some interpretations of available data suggest fixed-AI may be an effective tool to minimize differences in sire fertility, providing a means to optimize use a below average fertility sire of desired genetic merit. More recently, fertility evaluations are used to identify optimum candidates for sex-sorting procedures, which are known to significantly compromise conception potential. However, correlations between fertility estimates based on conventional and sex-sorted semen largely imply this may be an exercise in futility. Unfortunately, the level of adoption of AI has not been mirrored by the beef industry and presently it is estimated that <10% beef females are bred by AI. Among those bred by AI, most are not submitted for pregnancy diagnosis. Furthermore, no centralized data reporting system currently exists to collect, analyze, and estimate sire fertility potential from the very limited data that does exist. With the exception of limited research trials and small amounts of anecdotal data, AI center quality control programs are largely forced to extrapolate knowledge of the relationship of semen quality and fertility from dairy sires to beef sires.

Key Words: sire fertility, sex-sorted semen, artificial insemination

POSTER PRESENTATIONS

Extension—Beef/Small Ruminant

57 Comparison of top versus bottom strata of tall fescue interseeded with Kura-clover pastures. M. H. Ramos*¹ and J. W. Lehmkuhler², ¹University of Missouri, Columbia, ²University of Kentucky, Lexington.

One experiment was performed with the objective of measure forage quality differences between top and bottom strata of the sward. Two 5.6-ha pastures were divided into 8 paddocks of 0.7 ha each. Pasture was composite of soft leaf tall fescue (*Festuca arundinacea*) interseeded with Kura clover (*Trifolium ambiguum*) (60% clover). Percentage of clover was determined using hand grab samples of pure grass and legume and mixing it in different proportions (0% to 100% legume) to create a standard curve. The R² for clover prediction equation using NIRS was 0.93 with a standard error of calibration (SEC) of 9.08. A sample from pasture was collected from every other paddock and the calibration curve was used to predict the percentage of clover in the mix. A square measuring 60 cm X 60 cm was thrown 4 times in every even paddock during the grazing season and from each corner of the square a handful of sample was cut leaving a residue of approximately 5 cm. Care was taken to maintain the plants in the same orientation as harvested with rubber bands being placed around the sample. Samples were frozen for 4 d. After the animals were removed from the paddock one person walked from one corner to the other and repeated this for the opposite corners forming an X pattern in which disc meter readings of residual heights were recorded every 2 steps. This residual height was used to cut the samples into a bottom (BOT), post-grazing residual and top strata (TOP), consistent with what was assumed to be consumed by animals. Percentage of clover was higher ($P < 0.05$) for TOP compared with BOT (70 vs. 10%, respectively) only during the month of July. The fiber variables (NDF, ADF and lignin) were not significant different ($P > 0.05$) between BOT and TOP (45% vs. 48%, 29% vs. 35% and 7% vs. 6%; respectively). Crude protein were above 14% and not significant different ($P = 0.70$) between BOT and TOP. In vitro dry matter digestibility were above 80% for both treatments and no significant differences ($P = 0.77$) were reported between treatments. We concluded that legume forage structure, having leaves from middle to the top of the plant, was the main purpose of having uniform strata from BOT to TOP.

Key Words: legume, kura clover, fescue, grazing

58 Comparison of dry matter intake of cattle grazing cool season grasses receiving nitrogen or interseeded with legumes. M. H. Ramos*¹ and J. W. Lehmkuhler², ¹University of Missouri, Columbia, ²University of Kentucky, Lexington.

One experiment was performed with the objective of measure DMI differences between soft leaf tall fescue (*Festuca arundinacea*) interseeded with Kura clover (*Trifolium ambiguum*) (SL-KC, 60% clover) or soft leaf tall fescue only (SL, 0% clover). Two 5.6-ha pastures were divided into 8 paddocks of 0.7 ha each. Percentage of clover was determined using hand grab samples of pure grass and legume and mixing it in different proportions (0% to 100% legume) to create a standard curve. The R² for clover prediction equation using NIRS was 0.93 with a standard error of calibration (SEC) of 9.08. Samples from both pastures were collected from every other paddock and the calibration

curve was used to predict the percentage of clover in the mix. Holstein steers (285 kg /- 23) were used to graze those endophyte-free pastures during the spring and summer. Steers were bolused with titanium for 8 d (7 d adaption and one-day collection) and feces were collected from the rectum 3 times during the last day. PROC MIXED was used with pasture (SL-KC or SL) as a fixed effect, and paddock and animal as a random effect. Forage quality (NDF, ADF, CP and IVDMD) was not different between treatments ($P > 0.05$). Cattle on SL-KC reported a higher DMI than cattle on SL (8.7 vs. 6.8 kg/d, respectively, $P = 0.044$). When DMI was expressed as a percentage of the body weight, cattle on SL-KC also reported a higher DMI than cattle on SL (2.8 vs. 2.1% of the body weight, respectively, $P = 0.0004$). When comparing season, cattle ate more during the summer than the spring (8.6 vs. 6.9, respectively, $P = 0.06$) but when DMI was expressed as a percentage of the body weight, no differences were reported between season (2.4 vs. 2.5% of the body weight, respectively, $P = 0.55$). We conclude that the higher performance of animals grazing pastures with a mixture of legume is due mainly because of higher DMI.

Key Words: grazing, cattle, nitrogen, legume

59 Pasture supplementation: Variation in feed efficiency and average daily gain. M. H. Ramos* and M. S. Kerley, University of Missouri, Columbia.

A review of the literature on supplementation to grazing stocker cattle was performed via metanalysis. Pastures were classified into grass-legume (high quality grass with or without legume; orchardgrass, non-infected tall fescue and brome grass); bermudagrass (bermudagrass only); infected tall fescue (infected tall fescue only) and range (bluegrama grass, western wheat grass, big bluestem grass, sand hill meadow). For each pasture type, PROC UNIVARIATE from SAS was used to establish 4 percentiles. After pastures were assigned PROC GLM was used to analyze variation between treatments by pasture type. Average and standard deviation for body weight (kg), length of supplementation (days), gain to feed (GF) of supplement (kg: kg) and net energy of gain (NEG, kg of Mcal) were: 248 ± 38, 114 ± 41, 0.13 ± 0.09 and 2.64 ± 1.99 for grass legume; 261 ± 33, 145 ± 67, 0.09 ± 0.06 and 1.38 ± 1.75 for bermudagrass; 280 ± 33, 91 ± 15, 0.14 ± 0.09 and 2.06 ± 1.51 for infected fescue and 278 ± 36, 81 ± 77, 0.18 ± 0.12 and 1.40 ± 1.40 for range grass. For grass-legume pasture there was a linear decrease in GF ($P = 0.02$) and a linear increase in ADG ($P < 0.0001$) as supplement increased. The minimum and maximum values for GF for low level of supplementation (0.02 and 0.35) had a higher variance than higher level of supplementation (0.03 and 0.13). For bermudagrass pastures there was a linear decrease ($P = 0.01$) in GF and a quadratic increase ($P = 0.05$) in ADG as supplement levels increased. For infected fescue pastures there was no effect in GF but a quadratic effect was present for ADG ($P = 0.003$) when supplement level increased. The variations between the minimum and maximum values for GF were not different when level of supplementation was increased. For range grass there was a linear decrease ($P = 0.01$) in GF and a quadratic increase in ADG ($P = 0.05$) when level of supplementation increased. We concluded that GF will decrease and ADG will increase when supplementation levels increase, the point where

those lines meet should be considered as the most efficient point of supplementation.

Key Words: pasture, supplementation, stocker, grass

60 Sheep nutrition companion module to BRaNDS. G. Gahlke,*
D. Morrical, and D. Dewitt, *Iowa State University, Ames.*

The Sheep Nutrition Companion Module to BRaNDS (Beef Ration and Nutrition Decision Software) is a PC based software designed for the formulation and evaluation of sheep diets in both commercial and research spheres. This program was built to fill the need to provide a practical sheep nutrition software package that is affordable for producers yet complete in addressing the nutritional needs as now expressed in the 2007 National Research Council's publication, the Nutrient Requirements of Small Ruminants. The use of metabolizable protein,

net energy, effective neutral detergent fiber, fat soluble vitamins and minerals are incorporated in the various balancing modules of the program which include; mature ewe, breeding ram, replacement ewe lamb, the developing ram lamb, the feedyard lamb finishing and the grass finishing lamb. A default feed library containing over 100 different reference feedstuffs, ration summary reports, batch mixing reports, target supplement reports and in the professional edition, feed-out projection reports along with a custom supplement formulation screen are included in the program. This program, like its predecessor, BRaNDS, is available in both a professional and a standard edition. The interface is visible through Microsoft (MS) Excel allowing the standard form of the program to be operated in any MS Excel accommodating environment. The Professional version is written in MS Visual Basic and also uses the MS Excel interface, but may not lend itself to be operated outside of the MS Excel interface.

Key Words: sheep, software, nutrition, brands

SYMPOSIA AND ORAL SESSIONS

Extension—Dairy

61 Distance coverage study of the self-powered sensor based smart wireless identification and tracking tag for production agriculture application. K. Dhakal^{*1}, T. Ma², M. Hempel², J. F. Keown¹, and H. Sharif², ¹University of Nebraska, Department of Animal Science, Lincoln, ²University of Nebraska, Department of Computer and Electronics Engineering, Lincoln.

A prototype smart animal ear tag has been developed to meet the United States Department of Agriculture (USDA) animal disease traceability requirement. This novel smart tag is a self-powered device capable of complete animal identification and tracking. It also integrates sensors to monitor real-time health conditions of livestock. Information on animal health, breeding and vaccination records can also be locally stored and retrieved from these small, economical and securely accessible wireless tags. These smart tags are capable of self-organizing into wireless ad-hoc networks for data reporting and retrieval. This work presents our study of: 1) the effective distance coverage of a smart tag for a single hop and 2) the distance range for relaying through multiple tags (multi-hop communication). Six prototype smart tags were used in the experiment for this study. Distance was taken as a dependent variable and signal packets as an explanatory variable. The estimate of the intercept is 43.409 and the independent variable signal packets is -0.7634 ; giving distance = $43.409 - 0.7634 * \text{signal packets}$ as a fitted line. The mean distance range for a single hop is measured to be 22.6 ± 1.38 m. The total distance coverage using 6 tags plus the central computer receiving station using multi-hop communication was 136 ± 1.58 m. However, due to their ad-hoc wireless nature, the true size of the network is only limited by the number of available smart tags. The more tags are connected, the larger the network will become and the larger the provided coverage area will be. With encrypted information for data privacy, wireless identification and its ability to operate purely on energy harvested from its environment such as solar power, body heat, animal motion, and ambient RF; the smart ear tag would be very beneficial in livestock production environments compared with other animal identification technologies.

Key Words: smart tag, self-powered, tracking, wireless

62 (Invited ADSA Young Dairy Scholar) On heterogeneous associations between milk production and reproduction in dairy cows. N. M. Bello^{*1}, J. P. Steibel², R. J. Erskine², and R. Tempelman², ¹Kansas State University, Manhattan, ²Michigan State University, East Lansing.

The series of studies presented herein have as a main objective to investigate the nature of the association between milk production and reproductive performance of dairy cows taking into consideration its within-herd (cow-level) and between-herd (herd-level) components. We also evaluate management practices and herd attributes as potential sources of heterogeneity in this association. We implement recently developed bivariate hierarchical Bayesian models to explore heterogeneity in cow-level and herd-level production-reproduction associations using large data sets from commercial dairy farms in Michigan. The proposed hierarchical Bayesian models introduce a new dimension of heterogeneity to study the mutual association between production systems and individual animals, namely that of heterogeneous covariances (or correlations) between outcomes of interest. Evidence for

heterogeneity in the association between milk production and reproduction was overwhelming. Most notably, inferred associations were generally quite different and, in some cases, opposite in sign between the cow-level and the herd-level components. Second, management practices and herd attributes were identified as sources of heterogeneity in the production-reproduction relationship. In particular, intensive management conditions led to a more favorable association between production and reproduction in some cases (e.g., estimated herd calving interval decreased by 1.4 ± 0.1 d per 100 kg increase in cumulative milk yield for herds using bovine somatotropin treatment) or to a partial alleviation of an overall antagonism in others (i.e., 21% greater pregnancy rates among herds implementing more frequent milking schemes). Understanding the multidimensional levels of heterogeneity in the associations between milk production and reproductive performance should have direct implications for tailoring dairy management programs that optimize overall dairy cow performance in current production systems.

Key Words: dairy cow, heterogeneous association, milk production, reproduction

63 Does size of a dairy farm affect its carbon footprint? J. Paulson^{*1}, T. Olson¹, and G. Thoma², ¹University of Minnesota, St. Paul, ²University of Arkansas, Fayetteville.

A survey of 12 Minnesota dairy farms was conducted the summer of 2009. Farms ranged in size from 45 to 750 cows with a variety of housing, cropping and manure handling methods. From the data collected, kg of CO₂ equivalent/ kg of Fat and Protein corrected milk produced (FPCM) was calculated using a weighted delta-log mean distribution. Data was compared with LCA (Life Cycle Assessment) data for MN and the Region. Comparisons were made for Feed, Enteric, Manure, Fuel, and total farm footprint. Except for single outliers, there was little correlation to herd size for the calculated carbon footprint for items considered except for total farm. Data analyzed will determine needs for education among Minnesota farms.

Table 1. Weighted Delta Log Normal Statistics - all units Kg CO₂e/kg FPCM

		Fuels	Enteric	Feed	MMS	Total
Region 3	Mean	0.073	0.411	0.303	0.336	1.119
	lower 95% CI	0.070	0.404	0.297	0.309	1.092
	upper 95% CI	0.077	0.417	0.310	0.364	1.147
National	Mean	0.068	0.428	0.333	0.410	1.228
	lower 95% CI	0.064	0.423	0.327	0.386	1.204
	upper 95% CI	0.072	0.434	0.339	0.436	1.252
Minnesota	Mean	0.063	0.418	0.317	0.365	1.160
	lower 95% CI	0.057	0.407	0.305	0.317	1.107
	upper 95% CI	0.069	0.430	0.328	0.419	1.217
Twelve farms	Mean	0.075	0.397	0.275	0.327	1.072
	lower 95% CI	0.063	0.382	0.261	0.255	1.004
	upper 95% CI	0.089	0.414	0.290	0.421	1.145

Key Words: dairy, carbon footprint, sustainable

64 (Invited ADSA Young Dairy Scholar) The effect of dietary trace minerals source and amount during the dry period on health and performance of the dam and progeny. G. L. Golombeski¹, J. Linn¹, H. Chester-Jones², M. Socha³, and M. Raeth-Knight¹, ¹University of Minnesota, St. Paul, ²University of Minnesota, Southern Research and Outreach Center, Waseca, ³Zinpro Corporation, Eden Prairie, MN.

Trace minerals (TM) such as Co, Cu, Mn, and Zn have important roles in physiological processes related to growth, reproduction, and health. Studies have confirmed that feeding amino acid complexes of trace minerals to dairy cattle pre- and postpartum may result in improved milk yield, immune function, decrease incidence of hoof health and mastitis. There is limited research evaluating the effect of trace mineral supplementation during the dry period on nutrient composition and immunoglobulin content of colostrum. Supplementation of organic zinc sources during gestation in swine and the pre-hatch period in chickens has increased development of intestinal villi and enhanced nutrient absorption in the offspring. The objectives of the current study were to investigate the effects of supplemental dietary TM source and amount during the dry period on: 1) health and performance of dairy cows at parturition and during the subsequent lactation and 2) health, and growth performance of calves during the first 56 d of life. Fifty-two Holstein and cross-bred cows at the University of Minnesota-St. Paul and 62 Holstein cows at the University of Minnesota-Northwest Research and Outreach Center were randomly assigned to 1 of 3 treatments. Treatments were source of TM and amount of Zn supplementation: CON = inorganic; OTM = 1/3 organic and 2/3 inorganic; and OTMZ = OTM with additional Zn from zinc-methionine. Treatments provided the following supplemental TM during the dry period: CON = 25, 193, 410 and 1375 mg/d of Co, Cu, Mn, and Zn respectively; OTM = 24, 205, 406, and 1337 mg/d respectively; and OTMZ = 10, 133, 336, and 3092 mg/d respectively. Under conditions of this study, TM source or Zn supplementation of the dam prepartum did not affect liver TM concentrations of the dam at parturition or subsequent lactation performance or daily gain of calves through 56 d of life ($P \geq 0.05$).

Key Words: trace minerals, dry cows, colostrum, calf performance

65 Calculating starch digestibility by lactating dairy cows from starch concentrations in feed and feces. F. N. Owens* and A. T. Hassen, *Pioneer Hi-Bred International, Johnston.*

The relationship of starch digestibility to starch concentration of feed and feces was examined by compiling starch digestion data from published research trials with lactating dairy cows. The 235 corn-based diets in the data set averaged $28.0 \pm 6.1\%$ starch (DSTA) and $92.0 \pm 5.6\%$ starch digestibility (SD). Where not presented, fecal starch concentration as a percentage of fecal organic matter (FSTA) was calculated from reported digestibility of starch and of dry matter or organic matter. As a fraction of fecal organic matter, FSTA averaged $7.2\% \pm 5.0\%$ with a range from 0.6 to 25.8%. SD was not significantly correlated with dietary CP, NDF, or ADF, but SD was associated ($P < 0.05$) with diet OM, FSTA, and fecal NDF. Models were built by simple regression procedures, by ANOVA with study as a fixed effect, and by mixed model procedures with and without weighting by the standard deviation of SD. In addition, 27 data points were reserved for validation. Equations developed by different procedures had similar intercepts and slopes. Models to calculate SD were built using FSTA alone, with FSTA plus DSTA, and with these 2 factors plus FSTA x DSTA. Based on the mixed model approach without weighting, equations for these 3 model types were: $SD = 99.95 - 1.1367 \times FSTA$ with $r = 0.96$ and $SEP = 0.47$; $SD = 95.29 - 1.1677 \times FSTA + 0.18559 \times DSTA$ with $r = 0.99$ and $SEP = 0.25$; and $SD = 99.63 - 2.2489 \times FSTA + 0.02168 \times DSTA + 0.037546 \times FSTA \times DSTA$ with $r = 0.99$ and $SEP = 0.21$. Results indicate that starch digestibility by lactating cows in digestion trials could be predicted reliably from DSTA and FSTA alone. This indicates that analysis of feed and feces should prove useful to quantify SD at commercial dairies. Precision of estimates of SD from FSTA likely will be limited less by imprecision of these equations than by inability to obtain a representative sample of feces.

Key Words: starch, digestibility, feces, dairy

Extension—Dairy: Using Computerized Tools in Dairy Management

66 (Invited) Exploring methods to assess the economic value of dairy cattle reproductive programs. V. E. Cabrera,* *University of Wisconsin, Madison.*

A direct relationship between reproductive performance and profitability has long been recognized, but its quantification remains a challenge. The assessment is difficult because the most important economic factors of a dairy farm business such as lactation length, culling and mortality, calving interval, and cost of reproductive programs interact dynamically with the reproduction efficiency. Therefore, the prediction of the demographics and their economics of a dairy herd under a reproductive program requires sophisticated techniques, which together with farm specific conditions, warrant the need of a suite of methodological options. This study explores the utilization of adjusted partial cash flows (APF), Markov-chain (MC) simulations, and dynamic programming (DP) optimizations to assess the value of reproductive programs. The objectives are: 1) describe the application of these techniques to reproductive economic evaluation and 2) discuss the strengths and weaknesses of these methods under practical applica-

tions. The APF uses reproductive events to estimate partial economic values, which are discounted to the present, aggregated, and adjusted to a defined unit of time. The APF allows for large detail in the definition of reproductive programs, but is limited in the inclusion of the interactions of several lactations, abortions, and replacement events. The MC simulates a herd and its replacements for long periods of time to have an economic assessment resulting from a final (constant) herd structure. The MC overcomes the APF limitations, but requires reproductive programs to be adjusted to the dimensions of the model. The DP is the most complex framework based on Markov-chain arrangements that optimizes the dairy herd structure under a defined reproductive program. A major limitation of DP is that it is less suitable for user-friendly decision support systems. Overall, these models are reporting that pure timed artificial (TAI) insemination programs outperform to those pure heat detection (HD) programs and that the combined TAI with HD could be better or worse than pure TAI programs depending on the HD performance.

Key Words: simulation, modeling, reproductive efficiency

67 (Invited) Linear programming to evaluate the economics of reproductive efficiency and sexed semen considering herd constraints. A. De Vries,* *University of Florida, Gainesville.*

Linear programming is a technique for the optimization of a linear objective function, subject to linear equality and linear inequality constraints. The technique can be used to evaluate optimal replacement and insemination decisions for dairy heifers and cows considering herd constraints. A herd constraint such as a closed herd or a limiting milking parlor capacity implies that optimal insemination and replacement decisions for individual animals are not independent. Therefore, simultaneous calculation of optimal decisions for all animals in the herd is needed. A linear programming model was developed to evaluate the optimal semen mix in a closed herd considering conventional dairy semen, sexed female dairy semen, and conventional beef semen. The model considered a maximum of 10 parities including heifers. Heifers and cows were allowed at most 8 and 10 insemination opportunities per parity, respectively. Time step between insemination decisions depended on service rates. Inputs were genetic merit of calves by age and level of milk production of the dam and semen type, lactation curves, milk price, feed costs, insemination costs, conception rates, dystocia costs, involuntary culling risks, and other variable and fixed costs. Herd constraint was the requirement that enough born dairy heifer calves were raised to replace culled cows. Extra heifer calves were sold at \$200, dairy bull calves at \$50, and crossbred calves at \$150. As a result, in heifers 49% of all inseminations were with conventional dairy semen, 41% with sexed semen, and 10% with beef semen. In first parity cows, these percentages were 53%, 30%, and 17% respectively. In later parity cows, 42% of all inseminations were with beef semen. When the crossbred calf price was increased to \$300, the use of sexed semen in heifers increased to 76% of all inseminations and the use of beef semen in first parity and later parity cows increased to 45% and 71%, respectively. Including seasonality in milk production and fertility resulted in the use of beef semen in cows and sexed semen in heifers primarily during the winter and conventional semen during the summer. These illustrations show that the linear programming model formulation allows for exploring realistic optimal replacement and insemination decisions when herd constraints need to be considered.

Key Words: reproduction, sexed semen, constraint

68 (Invited) Stochastic modeling of the economic and biological risks associated with Precision Dairy Farming investment decisions. J. M. Bewley,* *University of Kentucky, Lexington.*

Dairy managers must consider both biological and economic considerations simultaneously in their decisions. Traditionally, investment decisions have been made using standard recommendations, rules of thumb, consultant advice, or intuition. But, more objective methods of investment analysis are needed. Empirical comparisons of technology before or after adoption or between herds that have adopted a technology and control herds that have not adopted are expensive and biased by other, possibly herd-related differences. A dynamic, stochastic, mechanistic simulation model of a dairy enterprise was developed to evaluate the cost and benefit streams coinciding with investments in Precision Dairy Farming technologies. This approach addresses many issues that have been a hindrance to this type of analyses. For example,

enumerating the risk of response to technology investment is difficult especially if the technology has no history from which to enumerate probabilities. Management must rely on expert opinion as a first-best guess of what these risks would be. The model was constructed to embody the biological and economical complexities of a dairy farm system within a partial budgeting framework. A primary objective was to establish a flexible, user-friendly, farm-specific, decision-making tool for dairy producers or their advisers and technology manufacturers. The basic deterministic model was created in Microsoft Excel (Microsoft, Seattle, WA). The @ Risk add-in (Palisade Corporation, Ithaca, NY) for Excel was employed to account for the stochastic nature of key variables within a Monte Carlo simulation. Net present value was the primary metric used to assess the economic profitability of investments. The model comprised a series of modules, which synergistically provided the necessary inputs for profitability analysis. Estimates of biological relationships within the model were obtained from the literature in an attempt to represent an average or typical US dairy. Technology benefits were appraised from the resulting impact on disease incidence, disease impact, and reproductive performance. The economic feasibility of investment in an automated BCS system and an automated temperature monitoring system were explored to demonstrate the utility of this model.

Key Words: stochastic modeling, investment analysis, Precision Dairy Farming

69 (Invited) Modeling and implementing feed management decisions into whole farm nutrient management. J. Harrison*¹ and A. Rotz², ¹*Washington State University, Puyallup,* ²*USDA / Agricultural Research Service, State College, PA.*

Feed management plays a major role in whole farm nutrient management. On most dairy farms, imported feed contributes more than 50% of the nutrients entering the farm. Export of nutrients from the farm in milk approximates 30% or less of the nitrogen and phosphorus consumed by the herd. Whole farm nutrient management must consider the magnitude and role that feed management decisions have on whole farm nutrient flows. Software tools are helpful when quantifying and evaluating feed management options. Three tools will be used to demonstrate the scope that feed management plays in whole farm nutrient management. The tools are: Whole Farm Balance Nutrient Education Tool (WFBNET) and Feed Nutrient Management Planning Economics (FNMP\$) (<http://www.puyallup.wsu.edu/dairy/nutrient-management/software.asp>); and the Integrated Farm System Model (IFSM - <http://www.ars.usda.gov/Main/docs.htm?docid=8519>). WFBNET was developed to quickly aid dairy producers with understanding nutrient management at the whole farm level. (FNMP\$) was developed to connect feeding decisions to the whole farm level and to estimate environmental and implication of feed management decisions. IFSM was developed to evaluate the impact of a wide range of management decisions such as cropping strategy, feeding options, manure handling methods, equipment selection, and weather factors on environmental and economic performance of farms. Factors such as forage selection and use of high phosphorus byproduct feeds will be used to show the impact that these decisions have on economics and environmental factors.

Key Words: dairy, feed Management, whole farm nutrient management

Wednesday, March 16, 2011

SYMPOSIA AND ORAL SESSIONS

Extension—Dairy: Controlling Infectious Claw Lesions with Footbaths and Potential Environmental Implications

70 (Invited) Hoofbaths and topical treatments to prevent and control digital dermatitis in cattle. Does best practice management of the hoofbath and prompt detection and treatment achieve clinical, histopathological and microbiological cure? A. Gomez,* A. F. Dusick, D. Döpfer, and N. B. Cook, *University of Wisconsin, Food Animal Production Medicine, Madison.*

Hoofbaths and topical treatments represent the most common strategies in DD prevention and control. Despite their widespread use, inconsistent results in decreasing DD prevalence have been reported, and many questions arise about their effectiveness. The complex DD etiology, inaccurate assessment of the disease, lack of standard methods for evaluating interventions aiming to control DD, and poor compliance with the control programs are the main reasons for the observed unsatisfactory results. Our research group has been focused on developing and identifying appropriate methods and management practices that will lead to an optimal use of the existing tools to control DD. In addition, innovative lines of research are being explored to enhance our knowledge of the disease and find possible new intervention strategies. To address the problems we currently face in the field, we will discuss the results from the following recent studies: 1. A hoofbath design trial to determine optimal dimensions to maximize foot steps per bath and minimize the volume of the chemical used; 2. A hoof bath field trial used to determine the clinical effectiveness of a novel hoofbath chemical, stressing the importance of long-term evaluation of products and the handling of individual cow susceptibility profiles in the analysis; 3. A bench-top assay to evaluate the minimum bactericidal concentration of chemicals for the control of *Treponema* spp, and 4. Clinical, histopathological and microbiological DD cure assessment from clinical cases sampled before and after topical treatment.

71 (Invited) Copper accumulation in dairy forage production systems. T. Downing, K. Stiglbauer, M. Gamroth,* and J. Hart, *Oregon State University, Corvallis.*

Dairy farmers often use either CuSO₄ or ZnSO₄ solutions in footbaths to control diseases of the hoof. Solutions are frequently changed before each milking requiring significant quantities of Cu and/or Zn a year. Used solutions are dumped into the dairy manure handling system and applied to fields in their liquid manure system. The objec-

tives for this project were to survey 30 dairy farms in Oregon to estimate the amount of CuSO₄ and ZnSO₄ used in footbaths, measure mineral concentrations in soils on the farm, access the concentration of Cu and Zn in the manure system and measure minerals in the forage produced on the dairy. Footbath practices were recorded for each dairy. Soils samples were collected from 2 major fields at 6" deep and analyzed for Cu and Zn. Forages grown on the farm were sampled and analyzed for Cu and Zn and manure was collected directly from milk cows and from the liquid manure storage system. Forages, soils and manure were all analyzed at Agri-Check Labs, Umatilla, OR. Footbath usage by farm ranged from no usage to continuous usage. Soil Cu concentrations ranged from 0.7 to 34.7 ppm and averaged 5.7 + 6.6. Soil Zn concentrations ranged from 0.6 to 41.8 ppm averaging 10.1 + 9.3. Forage copper concentrations ranged from 1 to 10 ppm averaging 3.4 + 2.1 and Zn ranged from 3 to 51 ppm averaging 13.8 + 10.3. Fresh manure Cu concentrations directly from milking cows were very consistent, typically at 10 ppm, with Cu concentrations in the manure storage ranging from 2 to 58 ppm averaging 10.3 + 12.02 ppm. The use of CuSO₄ and ZnSO₄ in footbaths on dairies in Oregon continues to be a common practice. Over 75% of dairy soils tested are considered high (>2ppm) in Cu concentration and 38% were extremely high (>5ppm). Using CuSO₄ and ZnSO₄ in footbaths is creating potential long-term environmental and cropping challenges on many Oregon dairies.

72 (Invited) Impact of high soil copper and zinc concentrations on crop production. J. Ippolito,* *USDA-Agricultural Research Service, Kimberly, ID.*

Hoof care is an important aspect of animal management. Copper or zinc sulfate (CuSO₄ or ZnSO₄) solutions are routinely utilized as a hoof bath regimen to prevent hoof diseases. When finished, the spent hoof bath solution is frequently disposed into lagoons with lagoon effluent later sprayed onto fields as a fertilizer source. Unfortunately, repeated application of Cu- or Zn-enriched lagoon effluent can result in topsoil metal accumulation. Because Cu and Zn are plant micronutrients, concern has arisen if this practice will result in a soil and subsequently a plant nutrient imbalance, thus leading to a decline in crop production. The role Cu and Zn play in higher plant nutrient, the potential for plant toxicity symptoms, and possible ways to mitigate future soil metal issues will be addressed.

Tuesday, March 15, 2011

SYMPOSIA AND ORAL SESSIONS

Extension—Swine

73 Effectiveness of the National Swine Nutrition Guide educational initiative in enhancing pork industry professionals' understanding of nutrition. R. C. Thaler^{*1}, M. S. Carlson², S. D. Carter³, G. Dahlke⁴, J. M. DeRouchey⁵, D. J. Meisinger⁶, J. F. Patience⁴, D. E. Reese⁷, B. T. Richert⁸, E. vanHeugten⁹, and M. H. Whitney¹⁰, ¹South Dakota State University, Brookings, ²University of Missouri, Columbia, ³Oklahoma State University, Stillwater, ⁴Iowa State University, Ames, ⁵Kansas State University, Manhattan, ⁶US Pork Center of Excellence, Ames, IA, ⁷University of Nebraska, Lincoln, ⁸Purdue University, West Lafayette, IN, ⁹North Carolina State University, Raleigh, ¹⁰University of Minnesota, Mankato.

The National Swine Nutrition Guide (NSNG) is a comprehensive education and extension effort by 9 faculty from Land Grant universities, the US Pork Center of Excellence and the United Soybean Board. The purpose of the NSNG is to provide practical, science-based feeding and nutrition information to US pork producers and their advisors to enhance their competitiveness. The NSNG book consists of 35 swine nutrition and management factsheets, a booklet containing the nutrient recommendation tables, and a diet formulation and evaluation software. Following its development, 9 training sessions on the NSNG and the diet formulation program were held across the US. A total of 265 people from 18 states, Canada and Japan, representing or influencing over 1,864,800 sows and 48,798,000 market swine (over 40% of the 2009 US annual production) attended the meetings. An exit survey completed by 58% of the participants revealed that 90% agreed or strongly agreed that the NSNG will be a useful tool for producers, university faculty, nutritionists, and industry professionals, 76% agreed or strongly agreed that the NSNG diet formulation program will be a useful tool for the swine industry, and 85% agreed or strongly agreed that the NSNG training session was beneficial. The NSNG training sessions resulted in a change to modern formulation strategies such as SID amino acids and available P by 45 and 82% of attendees, respectively, which will result in more cost effective and environmentally responsible swine production. Nutritionists (36%), graduate students (27%), and university faculty (12.4%) were the top groups responding to the survey. A follow-up webinar was held after the 8 training sessions were completed to address any questions that may have surfaced after the training sessions. Over 500 copies of the NSNG have been sold, and it is currently being translated into Mandarin for sale into China. The NSNG has proven to be highly effective in improving pork industry professionals' knowledge on the latest technologies in swine nutrition and management through Extension specialist collaboration.

Key Words: swine, nutrition, training

74 Effects on performance characteristics of immunologically castrated male pigs using different levels of lysine in the diets. S. S. Dritz^{*1}, M. D. Tokach¹, R. D. Goodband¹, J. M. DeRouchey¹, J. L. Nelssen¹, D. M. Meeuwse², V. L. King², P. L. Runnels², and J. P. Crane², ¹Kansas State University, Manhattan, ²Pfizer Animal Health, Kalamazoo, MI.

In global swine production systems where immunological castration is used to control boar taint, pigs physiologically function as entire males for a large portion of their lives and then transition to become more like a castrate after immunization. Historically, most studies which have compared the performance of immunologically castrated (IC) males with physical castrates or intact boars have used the same diet (usually barrow diet) with equal levels of lysine. Therefore, the lysine requirement of IC male pigs is not known. The objective of this study was to determine the effect on performance characteristics of IC male pigs using different levels of lysine in the diets. Male pigs (n = 1174) were raised in a commercial finisher and randomly assigned to 6 treatment groups: physical castrates (barrows) fed a standard lysine level diet for barrows (T01), IC pigs fed a standard lysine level for barrows (T02), IC pigs fed a medium low lysine diet (T03), IC pigs fed a medium high lysine diet (T04), IC pigs fed a high lysine diet (T05) and intact males fed a standard lysine level for intact males (T06). The lysine level fed to groups T01 and T02 were the same as were the lysine levels fed to groups T05 and T06. Pigs were housed approximately 25 to the pen with 8 pens per treatment group. Pen was the experimental unit. The 160 d feeding period was divided into 5 phases: nursery [Day 0 (weaning) to Day 55], grower (Day 55 to 76), developer, (Day 76 to 94), finish 1 (Day 94 to 122) and finish 2 (Day 122 to 160). Gonadotropin-releasing factor conjugate (IMPROVEST; Pfizer Animal Health) was administered via subcutaneous injection to groups T02, T03, T04 and T05 on Days 94 and 122. Pigs were commercially harvested on Day 162, 163 and 177. The average daily gain (ADG) of T04 pigs (0.79 kg) was significantly ($P < 0.05$) greater than that of T01 (0.75 kg) and not different ($P > 0.05$) from T06 (0.78 kg). Furthermore, the feed conversion efficiency (FE) of T04 pigs (2.41 kg feed/kg gain) was significantly ($P < 0.05$) better than that of T01 pigs (2.66 kg feed/kg gain) and not different ($P > 0.05$) from that of T06 (2.24 kg feed/kg gain). The medium-high lysine diet (T04) provided the best combination of ADG and FE within the IC male groups, also carcass quality and % carcass lean.

Key Words: performance, immunological castration, lysine

POSTER PRESENTATIONS

Extension—Swine

75 Effect of season of farrowing on litter size and lactation feed intake in gilts. L. Anil*¹, S. S. Anil², S. K. Baidoo¹, and J. A. Jendza¹, ¹University of Minnesota, Waseca, ²University of Minnesota, St Paul.

Season, housing system and management are the factors affecting breeding performance directly or indirectly. However, uniform management and genetics are needed to study the seasonal variation in reproductive performance in different housing systems. The objective of the study was to analyze the effect of season of farrowing on litter size at birth and lactation feed intake (LFI) in gilts, controlling for the effect of gestation housing system (stalls and group pens). The effect of season on LFI was included in this study given the effect of LFI on subsequent reproduction. The effect of season on litter size was analyzed using Poisson regression (Proc Genmod, SAS) and that on LFI was analyzed using the GLM procedure (Proc GLM, SAS). The study, conducted at the University of Minnesota Southern Research and Outreach Center, Waseca, utilized 1089 gilts housed in stalls (n = 539) and in group pens (n = 550) during 2002–2008. Gilts were artificially inseminated while they were in respective housing systems and moved to farrowing crate on 109 d of gestation. The results indicated that controlling for the effect of housing system, the litter size increased ($P \leq 0.05$) by 0.0643 units in fall (Sep–Nov) in comparison to winter (Dec–Feb). In other words, the litter size at birth increased by approximately 7% in fall in comparison to winter. Housing system was not associated with litter size in this analysis. The direction of the relationship was similar in spring (Mar–May) and summer (Jun–Aug), though not significant. Gilts farrowing during fall were bred during the previous April–July months, before the peak of summer. This could have helped to minimize embryonic loss and improve litter size. Both season and housing system were associated with LFI ($P \leq 0.05$ for both). The lowest amount of LFI for gilts was in summer (9.12 ± 0.142 kg/d) and the highest was in spring (10.12 ± 0.204 kg). Gilts housed in the groups consumed a higher quantity of feed (9.82 ± 0.117 kg/d) during lactation compared with the gilts housed in stalls (9.52 ± 0.137 kg/d). Results indicate that despite environmentally controlled housing systems, gilts are susceptible to seasonal effects in reproduction. The lower LFI in summer points to the need to adopt measures to improve feed intake during that time to minimize the effects on subsequent reproduction.

Key Words: gilts, litter size, lactation feed intake, season

76 Effect of NuPro™ on performance of weaned piglets. P. Spring¹, T. McArdle², J. Boyd³, S. Wilson³, J. A. Taylor-Pickard*², and K. Jacques⁴, ¹Swiss College of Agriculture, Zollikofen, Switzerland, ²Alltech, Lincolnshire, United Kingdom, ³BOCM PAULS, Norfolk, United Kingdom, ⁴Alltech, Nicholasville, KY.

NuPro™ (Alltech Inc., Nicholasville KY, USA) is an extract derived from a specific strain of yeast containing hydrolyzed protein and high concentrations of nucleotides. The objective of the present trial was to evaluate the effect of NuPro™ on performance and health of weaned piglets. The trial was setup as a 2x2x3 factorial design with the factors diet (control and NuPro™), sex (boar and gilt) and weight band (light, medium, heavy). Diets were iso-caloric and iso-nitrogenic and had the following specifications: First stage: 15.2 MJ DE, 21.5% CP, 1.70%

lysine; second stage: 15.0 MJ DE, 21.0% CP, 1.60% lysine. NuPro was included at 2.0% and did replace 2.0% fish meal. A total of 210 piglets with an average weight of 8.27 kg were assigned by body weight and sex to 36 pens of 5 piglets each. The trial lasted 4 weeks and feed intake, body weight and FCR were determined weekly. Animal health and mortalities were recorded daily. The data were analyzed as a 2x2x3 factorial design by ANOVA and means were separated by the test of Tukey-Kramer.

Overall performance and health was good: average daily gain: 424 g (SE 9.30 g); feed intake 556 g (SE 13.38 g); FCR 1.31 (SE 0.018). Feed intake of gilts was higher (575 vs. 536 g; $P < 0.05$) and weight gain tended to be higher (435 vs. 413 g; $P = 0.11$) than for boars. Weight band did not influence weight gain, but FCR was increasing from light to heavy piglets (1.24, 1.31, 1.38; $P < 0.001$). NuPro™ showed a strong tendency to improve weight gain (436 vs. 412 g; $P = 0.08$) and FCR (1.29 vs. 1.33; $P = 0.09$). Weight gain in wk 4 was significantly improved by NuPro™ ($P < 0.05$). Piglet uniformity at wk 4 was also improved with NuPro™ (13.85% vs. 17.81%). Following the 4-week trial period, the pigs were monitored through to slaughter to investigate the impact of NuPro™ on lifetime performance. Overall, average liveweight gain was similar (100.37 vs. 99.75 kg) as was daily liveweight gain (668 vs. 661g).

Key Words: NuPro, piglet, hydrolyzed protein, performance

77 Pork information gateway (PIG) provides scientific, peer-reviewed, and reliable information to producers, educators, students and industry professionals. D. J. Meisinger*¹, K. Mescher Collins¹, M. T. See², T. J. Baas³, E. Cortus⁴, P. J. Holden³, R. Knox⁵, K. Leedom⁶, Y. Li⁶, M. Morrow², S. Moeller⁷, D. Newman⁸, S. Pohl⁴, B. Richert⁹, J. Sterle¹⁰, ¹US Pork Center of Excellence, Ames, IA, ²North Carolina State University, Raleigh, ³Iowa State University, Ames, ⁴South Dakota State University, Brookings, ⁵University of Illinois, Urbana, ⁶University of Minnesota, St. Paul, ⁷Ohio State University, Columbus, ⁸North Dakota State University, Fargo, ⁹Purdue University, W. Lafayette, IN, ¹⁰Texas A&M University, College Station.

The Pork Information Gateway (PIG) Web site was launched in 2006, enabling and encouraging collaboration among universities while providing producers, educators, students and industry professionals an online forum for accessing reliable, scientific and peer-reviewed information. PIG categorizes information into 17 areas of pork production, ranging in topics covering swine health and reproduction to marketing and pork quality. Each area of PIG is led by a specialist from one of 11 universities or the National Pork Board.

PIG currently has registered users from all 50 states, the District of Columbia and Puerto Rico. Registration is free; the people registered with the Pork Information Gateway are owners (n = 815), educators (n = 471), managers (n = 449), extension personnel (n = 263), feed/pharma personnel (n = 228), students (n = 1323), consultants, (n = 332) veterinarians (n = 211), other (n = 595), employees (n = 160) and contract growers (n = 59). The information available on the Pork Information Gateway Web site includes peer-reviewed Factsheets (n = 284), step-by-step production guidelines called How-To's (n = 45),

Questions and Answers (n = 1612), Learning Courses (n = 7), and References (n = 1373). User visits were evaluated for 7 weeks between August 30, 2010 and October 24, 2010. During this period there was an average of 76 visits each week. A total of 399 individual people visited the Web site during the 7-week period; an average of 57 visitors each week. Each visitor spent an average of 4 min and 41 s at the site, with an average 7 page views.

Key Words: PIG, swine extension, fact sheets, swine information

78 Effect of crossfostering on survival and growth of swine from birth through nursery. J. A. Bishop^{*1}, J. P. Cassady¹, J. W. Holl², W. O. Herring², M. S. Culbertson², and M. T. See¹, ¹North Carolina State University, Raleigh, ²Smithfield Premium Genetics, Rose Hill, NC.

Cross fostering is a common practice in commercial swine production to balance number of pigs nursed per sow. The objective of this study was to estimate the effect of crossfostering on growth and survival from birth through nursery in a commercial farm. During a 4 wk period, litters (n = 403) were farrowed from multiparous Large White x Landrace females mated to Duroc boars. Prior to farrowing, sows were randomly assigned to one of 2 treatments, crossfostered (CF) or non-crossfostered (NF). Within 24 h of birth pigs were weighed and individually identified based on treatment group. Pigs within the CF group were fostered by farm personnel to balance litters for number of pigs nursed. Pigs were weaned in 4 weekly groups at 20.2 ± 1.9 d of age; 2 d before weaning all pigs were individually weighed and nurse sow recorded. A model with fixed effects of treatment and parity group and random effect of sire was fit using the Mixed Procedure of SAS to determine the effect of treatment on litter weaning weight. To determine the effect of treatment on survival the Glimmix procedure of SAS was used with a model including fixed effect of treatment and random effect of sire. Due to chance sows assigned to NF treatment had a tendency (NF = 11.57 ± 0.29, CF = 11.04 ± 0.28; *P* = 0.15) for greater number born alive. There was no difference in litter weaning weight between treatments (NF = 50.54 ± 1.11, CF = 52.32 ± 1.06; *P* = 0.20.) Survival odds were calculated at various time points from birth through nursery. Although there was a trend for CF group to have a higher pre-weaning survival (odds ratio = 1.14; *P* = 0.08), the survival odds for birth through nursery did not differ between treatments (odds ratio = 1.08; *P* = 0.25). Due to the limited effect on survival and litter weaning weight, it was concluded that this crossfostering protocol was of little or no benefit to performance from birth through nursery.

Key Words: pigs, survival, crossfostering, growth

79 Impact of immune system stimulation and dietary protein intake on expression of reference genes in liver, small intestine and spleen of growing pigs. A. Rakhshandeh,^{*} J. Zhang, and C. F. M. de Lange, University of Guelph, Guelph, ON, Canada.

Expression patterns of key regulatory genes help to understand the biological processes that control metabolism. Relative quantification of gene expression with quantitative real time PCR requires the use of stable reference genes. However, the expression levels of reference genes can vary among tissues and be affected by the subject's metabolic status. The impacts of immune system stimulation (ISS) and protein intake (Pi) on expression of reference genes were investigated. Restricted-fed barrows (BW 21.5 kg) were allotted to one of 2 levels of Pi (64 and 161 g/d) and injected with either saline (n = 8) or increasing amounts of *E. coli* lipopolysaccharide (n = 16) every 48 h for 7 d. Pigs were then killed to collect liver, small intestine (SI)

and spleen samples for RNA extraction. Tissue RNA was then reverse transcribed and expression of reference genes was determined using quantitative real time PCR. The GeNorm program was used to assess consistency of expression of 4 candidate reference genes: GAPDH, β2M, RPII and PBGD. Effects of ISS, Pi and their interaction (ISS × Pi) on gene expression were evaluated using MIX Procedures in SAS. Expression of PBGD was determined to be low (CT value >38) in the 3 tissues. In liver β2M, in small intestine GAPDH, RPII and β2M and in spleen GAPDH and β2M were determined to be the most consistently expressed reference genes, based on a measure of gene expression stability (M-value). In liver and spleen expression of GAPDH and RPII was affected by ISS and Pi (*P* < 0.03). Interactive effects were only observed for expression of β2M in SI (*P* < 0.02). In summary, consistency of expression of reference genes varied among tissues, and ISS or Pi resulted in differential expression of reference genes in liver, spleen and SI. These findings suggest that suitable reference genes are β2M in liver and spleen, and GAPDH and RPII in SI.

Key Words: immune system stimulation, gene expression, reference gene, pig

80 Comparative efficacy of LincoMix[®] and Tylan[®] for the control Of ileitis in a commercial swine farm. T. Hoover^{*1}, J. Hicks², D. Amodie¹, and M. Senn¹, ¹Pfizer Animal Health, New York, NY, ²Leading Edge Advanced Research, Carroll, IA.

Ileitis caused by *Lawsonia intracellularis*, (LI) is the most common cause of diarrhea in grow/finish swine in North America. LI infections result in clinical and subclinical symptoms. The subclinical form of infection often remains undetected but negatively impacts performance e.g., average daily feed intake, (ADFI), average daily gain, (ADG), and feed efficiency, (FE). This study assessed performance and economic impact of strategic feed medication compared with non-medicated controls. 898 pigs about 11 weeks of age (65 lbs) were sourced from 2 farms. Pigs were allotted to 1 of 3 treatments based on Day 0 wt and serologic profile in a randomized complete block design. Treatments were assigned at random to pens. All treatments appeared in each of 12 blocks of 3 pens. Significance was tested at the 10% level. T01, non medicated controls, T02, Lincomix[®] (Pfizer, NY, NY), Feed Additive pulse dosing for 1 wk. at 40g/ton at 16 and 20 wks. of age followed by no medication followed by continuous dosing at 20g/ton for the final 3 wks of the in life phase of the study, T03, Tylan[®] (Elanco, Greenfield, IN) Feed Additive at 100g/ton for 3 wks at 16 wks of age followed by continuous dosing at 40g/ton for the remainder of the in life phase -per label ADG - T01 pigs gained 1.79 lbs/d, T02, pigs gained 1.87 lbs/d, and T03 pigs gained 1.87 lbs/d. Both medicated groups, T02 and T03, had significantly higher ADG compared with controls, *P* = 0.0140 and *P* = 0.0150, respectively. ADFI - T01 (5.94), T02 (5.99), T03 (6.02). No significant differences (*P* > 0.10). F:G -T02 (3.20) was significantly lower compared with T01 (3.33) *P* = 0.0162; T03 (3.22) was significantly lower compared with T01 *P* = 0.0259. No other significant differences exist. TOTAL GAIN: T02 (150.4) was significantly higher than T01 (145.5), *P* = 0.0354. T03 (151.7) was significantly higher than T01, *P* = 0.0096. No other significant differences exist. In conclusion, performance of Lincomix is equal to Tylan for control of enteric disease in a herd with known exposure to L.I. Total cost for Lincomix in this study was \$0.76/pig and total cost for Tylan was \$2.11/pig. The return on investment, (R.O.I) was calculated at 2.18:1 for Lincomix and 0.22:1 for Tylan.

Key Words: subclinical ileitis, negative impact on performance, strategic feed medication

Monday, March 14, 2011

SYMPOSIA AND ORAL SESSIONS

Graduate Student Oral Competition—M.S.

81 Utilizing heifer RFI to predict cow intake and efficiency. J. W. Adcock,* D. W. Shike, D. B. Faulkner, and K. M. Retallick, *University of Illinois, Urbana.*

Angus and Simmental X Angus heifers (n = 62) were used to determine their residual feed intake (RFI) as yearlings using the GrowSafe® system. These animals were then evaluated for individual intake at 60 d postpartum (lactating period) and 240 d postpartum (dry period). Animals were fed a common diet during a 10 d evaluation period of an 85% grass-legume hay blend and 15% corn condensed distillers solubles. Weigh-suckle-weigh was used to determine milk production for the lactating period. In both periods, animals were weighed on consecutive days to determine weight. Hip height, BCS (1–9 scale), and backfat via ultrasound were measured. The individual animal DMI was determined for each period. The PROC REG procedure of SAS was used to determine which factors had the biggest influence on intake. During lactation period, heifer RFI, average weight, milk production, and quadratic milk production ($R^2 = 0.33$) influenced intake. Heifer RFI was removed and the prediction equation was used to predict dry matter intake (PDMI). Alternatively, NRC was used to predict dry matter intake (NRCPDMI) using the weight, BCS, and milk production. Cow RFI was calculated using both intake predictions (UIRFI and NRCRFI). For the lactating period, correlations were: heifer RFI and cow UIRFI (0.30), cow DMI and heifer DMI (0.28), cow PDMI and heifer PDMI (0.53), cow NRCRFI and heifer RFI (0.27), heifer DMI and cow NRCRFI (0.21), heifer DMI and cow UIRFI (0.13), heifer RFI and cow DMI (0.23), and cow NRCRFI and cow UIRFI (0.88). For the dry period the regression procedure showed that the only factor related to cow intake was heifer RFI ($R^2 = 0.07$), therefore no prediction equation was possible. As a result, NRCPDMI was calculated using weight and BCS. Correlations were cow DMI and heifer DMI (0.17), heifer RFI and cow DMI (0.27), heifer DMI and cow NRCRFI (0.12), as well as heifer RFI and cow NRCRFI (0.27). Heifer RFI is correlated with cow intake, cow UIRFI, and cow NRCRFI and thus can be used to help predict intake and efficiency.

Key Words: cow, intake, efficiency

82 Optimal dietary methionine to methionine plus cysteine ratio is increased during immune system stimulation in growing pigs. N. Litvak*¹, A. Rakhshandeh¹, J. Htoo², and C. F. M. de Lange¹, ¹*University of Guelph, Guelph, ON, Canada*, ²*Evonik Degussa GmbH, Hanau, Germany.*

Chronic sub-clinical levels of disease occur frequently in intensive swine production and compromise nutrient utilization efficiency. Sulfur amino acids (SAA), particularly cysteine, have been implicated in improving the animal's response to immune system stimulation (ISS), as substrates for compounds involved in the immune response, such as glutathione and albumin. A nitrogen (N) balance study was conducted to assess the optimal methionine to methionine

plus cysteine ratio (M:M+C) during ISS in 20 kg pigs. Thirty-six pigs were fed 800 g/d of one of 5 SAA-limiting diets, containing graded levels of M:M+C (42, 47, 52, 57 and 62%) and supplying 2.5 g/d of SAA. After adaptation, N balances were determined sequentially during a 5-d pre-ISS period and 2 ISS periods of 3 and 4 d, respectively. To induce ISS, pigs were injected intramuscularly with repeated and increasing doses of *E. coli* lipopolysaccharide. Eye temperature and blood parameters confirmed effective ISS. In the first ISS period, ISS reduced the mean N-balance more severely than in the second ISS period (8.7 ± 0.3 vs. 9.6 ± 0.4 g/d) and was lower than the pre-ISS period (10.0 ± 0.2 g/d). An interactive effect of ISS and diet on N balance was observed ($P < 0.001$). Quadratic-plateau regression analysis determined the optimal dietary M:M+C to be $56.6 \pm 2.6\%$ and $58.8 \pm 2.4\%$ for pre-ISS and ISS period 2, respectively. The optimal dietary M:M+C for ISS period 1 was found to be greater than the highest level in the present experiment (62%), suggesting that the optimal M:M+C is greater during initial ISS. It is suggested that this may be a result of toxic properties of cysteine, and preferential use of methionine during ISS. This is supported by the elevated transsulfuration rate previously noted during ISS mainly due to the enhanced cystathionine β -synthase enzyme activity. In conclusion, ISS results in an increase in the optimal dietary M:M+C in growing pigs.

Key Words: immune system stimulation, sulfur amino acids, N balance, growing pigs

83 Granulated lysozyme as an alternative to antibiotics improves growth performance and small intestinal morphology of 10-day-old pigs. K. D. May*¹, J. E. Wells², C. V. Maxwell¹, and W. T. Oliver², ¹*University of Arkansas, Fayetteville*, ²*USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

Lysozyme is a 1,4- β -N-acetylmuramidase that has antimicrobial properties. The objective of this experiment was to determine the efficacy of granulated lysozyme, compared with antibiotics, on growth performance, small intestinal morphology, and *Campylobacter* shedding in 10-d-old pigs. Forty-eight pigs (n = 16), with an initial weight of 4.0 ± 0.1 kg ($P > 0.40$) were weaned at 10 d of age, blocked by litter and gender, and assigned to pens (8 pigs/pen). Each block was randomly assigned to consume one of 3 liquid dietary treatments for 14 d; Control (C), C + lysozyme (100 mg/kg diet, L), or C + neomycin and oxytetracycline (16 mg/kg diet, A). Pigs were weighed and bled on d 0, 7, and 14. Blood was analyzed for plasma urea nitrogen (PUN) and immunoglobulin A (IgA). After 14 d of treatment, pigs were killed and jejunum and ileum samples were collected and fixed to measure villi height and crypt depth. Rectal swabs were taken on d 0 and 7 of treatment, and ileum, cecum, and rectal swabs were taken at d 14 to determine the presence of *Campylobacter*. L and A pigs gained at a faster rate than C pigs over the course of the study (402 ± 12 and 422 ± 14 vs. 364 ± 14 g/d; $P < 0.02$), resulting in heavier ending BW (9.9 ± 0.3 , 9.9 ± 0.3 , and 9.0 ± 0.2 kg for L, A, and C pigs, respectively; P

< 0.03). IgA decreased and PUN increased over the course of the study ($P < 0.1$), regardless of dietary treatment ($P > 0.6$). Crypt depth was increased in L and A pigs, compared with C pigs, in both jejunum (60.0 ± 2.8 and 62.2 ± 3.0 vs. 50.7 ± 3.1 μm ; ($P < 0.03$) and ileum (76.0 ± 7.5 and 72.2 ± 5.0 vs. 52.4 ± 3.5 μm ; ($P < 0.02$). Villi height did not differ in the jejunum ($P > 0.2$), but was increased in the ileum of L and A pigs, compared with C pigs (312 ± 20 and 314 ± 10 vs. 263 ± 15 μm ; ($P < 0.4$). *Campylobacter* was detected in 27% of C samples, but in only 5% of A samples and 8% of L samples ($P < 0.01$). Thus, granulated lysozyme is a suitable alternative to antibiotics for 10-d-old pigs consuming manufactured liquid diets.

Key Words: antibiotics, lysozyme, swine

84 BVDV2 titer level relationships with growth and body composition traits in Angus calves. E. D. Downey^{*1}, E. C. Conrad¹, K. K. Lintz¹, J. F. Ridpath², R. G. Tait, Jr.¹, D. J. Garrick¹, and J. M. Reecy¹, ¹Iowa State University, Ames, ²National Animal Disease Center/ARS/USDA, Ames, IA.

We evaluated correlations between bovine viral diarrhea virus type 2 (BVDV2) antibody titers levels during vaccination with growth traits in purebred American Angus calves. This study utilized 1,012 Angus calves born in spring and fall calving seasons from 2007 to 2009 and were administered a 2 shot vaccination protocol for BVDV2. Calves were allotted to one of 2 weaning groups, where half ($n = 512$) were weaned at initial vaccination and the other half ($n = 500$) were weaned at booster vaccination. Circulating antibody titer levels in serum were determined by viral neutralization (VN) assay. Mean VN scores (stated log base 2 of reciprocal dilution) were 3.04 at initial vaccination (IT), 4.01 at 3 weeks post-booster vaccination (PVT), and 0.96 for overall response (OR) to vaccination. IT level is a measurement of maternal antibodies that are present at start of the vaccination protocol. All 3 VN scores were correlated ($P < 0.05$) with calf age at collection, weaning hip height (HH), yearling rump fat thickness, yearling ribeye area, and average daily gain. Age at collection and HH were negatively correlated with IT ($r = -0.621$ and -0.356), but both traits were positively correlated with PVT ($r = 0.310$ for age and 0.156 HH) and OR ($r = 0.591$ for age and 0.331 HH). Whereas yearling carcass ultrasound traits ($n = 876$) were positively correlated with IT, and were negatively correlated with PVT and OR. Age-adjusted calf weights were positively correlated ($P < 0.05$) with PVT and OR, while IT was negatively correlated with age-adjusted weight at the initial serum collection. Calves with higher PVT and OR had higher weaning traits but reduced rump fat thickness and ribeye area. These data indicate there are potential relationships between response to vaccination and growth and body composition traits in Angus cattle, but it is unclear whether higher titers are a result of improved growth or improved growth results from better health and higher titers.

Key Words: cattle, growth, vaccination

85 Economic analysis of smooth bromegrass pasture beef growing systems. A. K. Watson,^{*} T. J. Klopfenstein, G. E. Erickson, W. H. Schacht, and D. R. Mark, *University of Nebraska, Lincoln*.

A 5 year study from 2005 to 2009 evaluated production and economic differences in 3 grazing management strategies for backgrounding calves on smooth bromegrass pastures. Two-hundred 25 steers (325 ± 22 kg) grazed the pastures annually from about April 20 to late September in a randomized complete block design. Treatments included pastures fertilized in March with 90 kg N/ha (FERT), non-fertilized pastures with calves supplemented daily with dried distillers grains

plus solubles (DDGS) at 0.6% of BW (SUPP), and control (CONT) pastures with no fertilizer or supplementation applied. Pasture was the experimental unit and was replicated 3 times. Both FERT and SUPP pastures were initially stocked at 9.9 AUM/ha and CONT at 6.8 AUM/ha, but variable stocking rates were used to maintain similar grazing pressure on all treatments. Six paddocks within each pasture were fenced and rotationally grazed in each of 5 grazing cycles through the grazing season. Total costs for each system included initial steer price plus interest, yardage, health and processing fees, death loss, and cash rent plus interest. The SUPP treatment also had additional costs of \$59.14/hd for DDGS supplement, while costs for the FERT treatment included \$35.48/hd for fertilizer application in the spring. Per head land costs were decreased for both FERT and SUPP treatments relative to CONT due to increased stocking rate. SUPP steers were 41 kg heavier than either FERT or CONT steers at the end of grazing which resulted in increased revenue of \$49.38/hd for the SUPP treatment ($P = 0.03$). Profit was greatest for SUPP at \$22.79/hd ($P = 0.02$), while both CONT and FERT lost money at $-\$6.20$ and $-\$8.71$ /hd, respectively. Cost of gain and breakeven prices were lowest for SUPP and not different between FERT and CONT treatments. In recent years, prices for N fertilizer have increased dramatically making the FERT treatment less profitable. In the future, the relationship between prices for land, N fertilizer, and DDGS will affect the profitability of all 3 treatments.

Key Words: dried distillers grains, forage

86 Weaning age and source of energy influences beef cattle performance, carcass characteristics, and economics. W. T. Meteer,^{*} D. B. Faulkner, D. W. Shike, J. W. Adcock, and K. M. Retallick, *University of Illinois, Urbana*.

Angus and Angus x Simmental calves ($n = 200$) were randomly allotted to one of 5 dietary treatments at 2 locations: Early Wean Starch Diet (EWS), Early Wean Fiber Diet (EWF), Creep Fed Starch Diet (CFS), Creep Fed Fiber Diet (CFF), or Control (CON). Early-weaned calves (~140 d of age) were placed in the feedlot, while normal-weaned calves remained with their dams on pasture (2 or 3 replications per location). After a 100 d treatment phase, calves were placed in the feedlot on a common diet. GrowSafe[®] was used to measure individual intake of all calves in the feedlot. In the treatment phase, early-weaned gained more than creep-fed (1.6 vs. 1.5 kg, $P < 0.01$), and creep-fed gained more than control calves (1.5 vs. 1.2 kg, $P < 0.01$). EWS had 15% lower intakes and were 13% more efficient than EWF ($P < 0.01$). In the finishing phase, creep-fed calves gained 9% more, had 7% lower intakes, and were 16% more efficient ($P < 0.01$) than early-weaned calves. CON were 5% less efficient and spent 19 more d on feed ($P < 0.01$) than the other treatments. Backfat was lower for the CON (1.2 vs. 1.1 cm, $P = 0.02$). Marbling score was higher for early-weaned cattle when compared with creep-fed cattle (586 vs. 500) and lower for the CON (476 vs. 543) than all other treatments ($P < 0.01$). Marbling score did not differ significantly when comparing source of energy. Economic analysis of marketing the cattle as feeder calves post-treatment showed profit was 17% higher for EWF than EWS ($P = 0.06$), 14% higher for CFF than CFS ($P = 0.06$), 24% higher for creep-fed than early-weaned ($P < 0.01$), and 23% higher for CON than the remaining treatments ($P < 0.01$). Economics analysis of a retained-ownership showed profit was 31% higher for EWF than EWS ($P = 0.03$), 32% higher for creep-fed calves than early-weaned calves ($P < 0.01$), and 22% higher for CON ($P < 0.01$). Early weaning and creep feeding will increase carcass quality and growing phase gains, but reduce profit in this study.

Key Words: creep feeding, quality, early wean

87 Relationship between litters per sow per year breeding value and sire progeny means for farrowing rate. C. E. Abell,* K. J. Stalder, and J. W. Mabry, *Iowa State University, Ames.*

The purpose of this study was to determine the relationship between individual sires breeding values (BV) for litters/sow/year (LSY) and progeny farrowing rate means. Breeding values for LSY were estimated using ASREML and the heritability for this data set was found to be 0.08 ($P < 0.01$). A data set from a commercial production system consisting of records for 48,663 sows from 9 herds was used for the analyses. Landrace, Large White, and F1 ($Y \times L$ or $L \times Y$) crossbred females were included in the analyses. Breed, contemporary group of last litter, parity of last litter, and herd status were used as fixed effects. All fixed effects were significant ($P < 0.01$). Age at first service was included as a quadratic covariate. Sows were considered to be removed, or active. Sire progeny farrowing rate means were calculated as total number of services divided by the total litters farrowed. The contemporary group was defined as the herd, year, and season (3 mo period) based on the sows' last parity. The correlation between the LSY BV and the farrowing rate of the sires was computed (SAS Inst., Cary, NC) implementing the previously mentioned model. When all sires were included in the analysis (2,392 sires), the correlation between the sire's LSY BV and mean for farrowing rate was 0.11 ($P < 0.01$). When sires with 5 or more daughters were included (1815 sires), the correlation was 0.15 ($P < 0.01$). When sires with 10 or more daughters were included (949 sires), the correlation was 0.21 ($P < 0.01$). This suggests that improving LSY could result in indirect improvement of farrowing rate as well.

Key Words: breeding value, litters/sow/year, farrowing rate, swine

88 Evaluating the procedures used for digestibility studies of minerals with grower pigs. D. W. Gowanlock* and D. C. Mahan, *The Ohio State University, Columbus.*

Historically when pig digestion trials are conducted, animals are placed into metabolism crates, adjusted for a 5–7 d period, followed by a 3–5 d collection. There has been interest recently on evaluating this procedure, particularly when microminerals are being evaluated. This experiment was a RCB design in 6 replicates. Two diets were compared in a 15 d digestion trial separated in 3 phases. Barrow pigs were initially fed a conventional C-SBM mixture from 20 kg BW and formulated to NRC requirements. The pigs were allotted on the basis of BW to 12 stainless steel metabolism crates at approximately 40 kg BW where they continued on the pretest diet for a 9 d period. The treatment diets contained nutrients that were either above or below the pigs requirement for Ca (0.92 vs. 0.59%), P (0.68 vs. 0.50%) and microminerals (NRC vs. 2x NRC) for a subsequent 15 d period. Feed intake was provided at 90% ad libitum during the adjustment period and maintained throughout the 15 d trial. Carmen red and indigo blue were used alternately as feed markers at 5 d intervals with total fecal and urine samples collected for each 5 d phase. Feed, feces and urine was analyzed by ICP for macro and micromineral content. The results demonstrated for phase 1 that when the low mineral diet was fed there was a lower fecal and urinary Ca ($P < 0.05$), and P ($P < 0.01$ for urine only), but the % digestibility was not significant. The results were similar for phase 2 and 3 but were less variable. For the essential microminerals (Cu, Fe, Mn, Zn) there was a lower fecal and urine Cu ($P < 0.01$) and a greater ($P < 0.05$) Cu digestibility when the low micromineral level was fed in phase 1. Period 2 and 3 resulted in similar responses as phase 1 for Cu. Fecal and urinary Fe, Mn or Zn was lower when the low microminerals were fed for periods 1, 2, and 3, but there

was no significant difference in Fe, Mn, or Zn digestibilities between high and low micromineral intakes. These results indicate that after a 5 d adjustment period the subsequent 5 d period can give satisfactory micromineral digestibility values.

Key Words: digestibility, microminerals, pigs

89 Thermal response of lactating sows within forced-air (FA) ventilated and evaporatively-cooled (EC) farrowing rooms. W. R. Martin,* D. J. Mathew, T. J. Safranski, D. E. Spiers, and M. C. Lucy, *University of Missouri, Columbia.*

Modern farrowing rooms for swine are EC so that indoor ambient temperature (T_a) is closer to thermoneutral during summer heat stress. Older facilities use FA ventilation with outside air for cooling, therefore, indoor T_a is warmer. The objective was to measure the thermal response of sows housed in FA and EC rooms at the South Farm (Columbia, MO) during June to August 2010. Sows assigned to a treatment (trt; FA, $n = 17$ and EC, $n = 18$) entered the rooms one wk before farrowing and remained in their respective rooms until weaning. Rectal temperature (RT) and respiration rate (RR, breaths per minute, bpm) were collected thrice weekly in the morning (AM; 0900h) and afternoon (PM; 1500h). Average daily outdoor high and low T_a ($^{\circ}\text{C}$) were 30.4 ± 2.8 and 19.8 ± 3.1 . Average daily high and low T_a ($^{\circ}\text{C}$) within the rooms were 30.1 ± 2.2 and 23.0 ± 2.1 for FA and 28.0 ± 1.0 and 22.8 ± 1.4 for EC. There was a trt by time interaction ($P < 0.01$) for RT because RT were similar in the AM (38.2 ± 0.1 and $38.3 \pm 0.1^{\circ}\text{C}$) but differed in the PM (38.7 ± 0.1 and $38.5 \pm 0.1^{\circ}\text{C}$) for FA and EC, respectively. There was an effect of day on RT ($P < 0.001$). RT increased from d 0 (gestating; $37.8 \pm 0.1^{\circ}\text{C}$) to d 28 (lactating; $38.9 \pm 0.1^{\circ}\text{C}$). Regardless of trt, older sows (parity ≥ 3) had a lower RT than younger sows (38.5 ± 0.1 , 38.5 ± 0.1 and $38.2 \pm 0.1^{\circ}\text{C}$ for parity 1, 2, and ≥ 3 ; $P < 0.08$). There was a trt by day interaction ($P < 0.001$) for RR. RR was similar during wk 1 (gestating; 64 ± 4 and 61 ± 5 bpm) but differed during the last wk of lactation (83 ± 7 and 57 ± 7 bpm) for FA and EC, respectively. A trt by parity interaction was detected for piglet weaning weight (WW; $P < 0.11$). Older sows had reduced piglet WW in FA compared with EC (5.2 ± 0.4 and 6.4 ± 0.4 kg). Treatment did not affect WW in younger sows (5.9 ± 0.4 and 5.8 ± 0.4 kg). In conclusion, EC reduces T_a and alleviates heat stress. Each parity responds to heat stress differently via a mechanism that involves nutrient partitioning toward the piglet. Project supported by NRI Competitive Grant no. 2007–55203–18261 from the USDA NIFA.

Key Words: swine, heat stress, sows

90 Effects of supplementing dried distillers grains with solubles to heavy, yearling stocker cattle during the last 90 days of grazing to improve preformance and carcass characteristics when utilizing a short feeding protocol. A. Stickel,* T. Houser, J. Drouillard, K. C. Olson, A. Pacheco, M. Macek, G. Parsons, K. Miller, L. Thompson, M. Dikeman, J. Unruh, and D. Blasi, *Kansas State University, Manhattan.*

The purpose of this research was to investigate the impact on feeding dried distillers grains with solubles (DDGS) to heavy stocker cattle during the late grazing season and to determine the impact of a shortened, high concentrate feeding period on carcass yield and quality. The experimental design was a randomized complete block design with a 2x3 factorial treatment arrangement. Factors consisted of DDGS supplementation during grazing (0 or 1% of BW as DDGS; DM basis) and

finishing d on feed (DOF) (75, 100, 125) with 2 replications. Crossbred steers (n = 144; 367 ± 18.46 kg BW) were stratified by weight and randomly assigned to 1 of 12 pastures. Cattle grazed native pastures for 90 d and were then placed into feedlot pens and fed a high concentrate diet. Carcass data were collected 24 to 48 h postmortem. During grazing 1%DDGS had greater ($P < 0.01$) ADG (1.11 vs 0.345 kg/d) than 0%DDGS, but 0%DDGS had greater ($P < 0.01$) ADG (1.67 vs 1.45 kg/d) than 1%DDGS treatment during the finishing period. There were no differences in DMI ($P = 0.91$) during the finishing period. Feeding 1%DDGS decreased ($P = 0.02$) G:F compared with cattle fed 0%DDGS. 1%DDGS had heavier ($P < 0.01$) carcass weights (362.5 vs 330.4 kg) and larger ($P = 0.02$) *longissimus* muscle area (LMA 90.4 vs 85.4 cm²) than 0%DDGS. Increasing DOF linearly increased HCW ($P < 0.01$), 12th rib fat thickness ($P = 0.03$), LMA ($P = 0.01$) and USDA marbling score ($P = 0.02$). No differences ($P = 0.28$) were observed for USDA yield grade. In conclusion, supplementing cattle with 1%DDGS improved grazing ADG resulting in heavier carcass weights and larger LMA. However, cattle fed 0%DDGS were more efficient and had increased ADG during the finishing period. Increasing DOF yielded heavier carcass weights, larger LMA, greater 12th rib fat thickness and improved USDA marbling score.

Key Words: beef cattle, dried distillers grains with solubles, grazing, carcass

91 Optimum dietary isoleucine and lysine levels in a barley-wheat based starter pig diet. L. Huber*¹, J. K. Htoo², D. Wey¹, C. H. Zhu¹, and C. F. M. de Lange¹, ¹University of Guelph, Guelph, ON, Canada, ²Evonik Degussa GmbH, Hanau, Germany.

Increased usage of supplemental amino acids (AA) and environmental pressures increase the need to better understand AA requirements of pigs. A 3 wk performance study was conducted to determine the optimal dietary standardized ileal digestible (SID) isoleucine (Ile) to lysine (Lys) ratio (Ile:Lys) for starter pigs between 10 and 25 kg BW, with 6 pens per treatment and 2 barrows and 2 gilts per pen. Nine barley-wheat based diets (1.2% isoleucine) with varying amounts of supplemental Lys and Ile were formulated: diets 1 to 4 and 9 contained 0.40, 0.47, 0.54, 0.61 and 0.68% SID Ile, respectively, and 1.21% SID Lys; diets 5 to 9 contained 0.72, 0.84, 0.96, 1.08, and 1.21% SID Lys, respectively, and 0.68% SID Ile. Pigs were fed ad libitum and plasma urea nitrogen (PUN) was measured in 2 pigs per pen on d 7 and 21. Pig growth performance increased linearly ($P < 0.01$) with increasing diet Lys level, indicating that SID Lys requirements are higher than 1.21% of diet for this population of pigs, and increased quadratically ($P < 0.01$) with increasing diet Ile. Numerically, highest BW gain, gain:feed and lowest d 7 PUN (0.92 mmol/L) were achieved by feeding diet 3 (Ile:Lys 0.45). Alternative regression models were fit to estimate the optimum Ile:Lys ratio, based on diets 1 to 4 and 9, with mean respective BW gains of 332, 510, 608, 559 and 578 g/d (SE 13.7 g/d) and gain:feed of 0.524, 0.606, 0.674, 0.641 and 0.677 (SE 0.02). Based on a linear-plateau broken-line model, the breakpoint for maximum BW gain was 0.42 Ile:Lys ($R^2 = 0.97$); for maximum gain:feed this value was 0.43 Ile:Lys ($R^2 = 0.95$). When using exponential models, 95% of plateau BW gain was achieved at 0.46 Ile:Lys ($R^2 = 0.96$); for gain:feed this value was 0.51 Ile:Lys ($R^2 = 0.92$). The optimum dietary SID Ile to Lys ratio is 0.42 to 0.46 for maximum BW gain, and 0.43 to 0.51 for maximum gain:feed, respectively, for this population of starter pigs between 10 and 22 kg BW and fed a barley-wheat based diet.

Key Words: starter pigs, isoleucine, growth performance, plasma urea nitrogen

92 Association of myostatin on weight, intake, and carcass traits in crossbred steers adjusted to different endpoints. S. K. Pruitt,* K. M. Rolfe, B. L. Nuttelman, W. A. Griffin, J. R. Benton, G. E. Erickson, D. C. Ciobanu, and M. L. Spangler, University of Nebraska, Lincoln.

The objective of this study was to investigate a potential association of an inactive myostatin allele with performance and carcass traits using 60 individually fed crossbred steers (280 ± 30 kg) with 0, 1, or 2 copies of the inactive myostatin allele (n = 19 homozygous active myostatin, n = 28 heterozygous, and n = 13 homozygous inactive myostatin, respectively). Steers were fed a finishing diet consisting of 52% corn, 35% wet distillers grains plus solubles, 8% hay and 5% supplement (DM basis) for 190 d. Ultrasound measurements of rump fat (RUF), rib fat (RIBF), LM area (uLMA) and intramuscular fat % (IMF) were taken at 28 d intervals over the feeding period. Age of steers across genotypes differed ($P = 0.04$) and was used as a covariate for analysis. Initial and final BW decreased linearly ($P < 0.01$) with the presence of the inactive myostatin allele. Intake and ADG linearly decreased ($P < 0.05$) from 0 to 2 copy steers with a quadratic response ($P = 0.05$) for G:F favoring 2 copy steers. Yield grade and 12th rib back fat linearly decreased ($P < 0.01$) from 0 to 2 genotypes. There was a quadratic response ($P < 0.01$) in carcass dressing percent and marbling for 0 to 2 copies (63.02, 64.36, and 68.63; 458.8, 415.7, and 238.3, respectively). Age, BW, RIBF and RUF were used to adjust weight and ultrasonically measured traits to a constant endpoint using within genotype regression estimates. Best fit endpoints for each trait were determined by comparing Akaike's information criterion (AIC) values. Best fit models for BW and uLMA included adjustments to RIBF and BW, respectively, and resulted in differences for all pairwise comparisons of genotypes ($P < 0.01$). Adjusting age to a RIBF or BW endpoint suggests 2 copy animals would require more days on feed compared with 0 copy animals to reach similar RIBF or BW at harvest. Results suggest the inactive myostatin allele decreases BW gain and increases percentage of red meat yield.

Key Words: beef, body composition, myostatin

93 Effect of crossfostering on survival and growth of swine in finishing. J. A Bishop*¹, J. P. Cassidy¹, J. W. Holl², W. O. Herring², M. S. Culbertson², and M. T. See¹, ¹North Carolina State University, Raleigh, ²Smithfield Premium Genetics, Rose Hill, NC.

Cross fostering is a common practice in commercial swine production to balance number of pigs nursed per sow. The objective of this study was to estimate the effect of crossfostering on growth and survival in a commercial finisher. During a 4 wk period, litters (n = 403) were farrowed from multiparous Large White x Landrace females mated to Duroc boars. Prior to farrowing, sows were randomly assigned to treatments, crossfostered (CF) or non-crossfostered (NF). Within 24 h of birth pigs were individually weighed and identified. Pigs within the CF group were fostered by farm personnel to balance litters for number of pigs nursed. Pigs were weaned in 4 weekly groups at 20.2 ± 1.9 d of age; 2 d before weaning all pigs were individually weighed and nurse sow recorded. A subset of pigs from 178 litters were followed through finishing. Finisher placement weight was recorded at 74.4 ± 1.9 d. Final weight, back fat depth (BF) and loin eye area (LEA) were measured before slaughter at 172.4 ± 2.0 d. Hot carcass weight (HCW) (litter n = 133) was obtained at slaughter at 196.8 ± 16.2 d, and fat-free lean gain per day (FFL) was calculated from these measurements. All growth and carcass data were averaged by nurse sow. A model with fixed effects of treatment and parity group and random effect of sire was fit using the Mixed Procedure of SAS to determine

the effect of treatment on growth and carcass traits. To determine the effect of treatment on survival the Glimmix procedure of SAS was used with model including fixed effect of treatment and random effect of sire. No difference was observed for survival between treatments from birth to final weight (odds ratio = 0.946; $P = 0.58$.) No difference was observed in the average FFL (NF = 0.34 ± 0.003 kg, CF = 0.34 ± 0.003 1kg; $P = 0.23$), average BF (NF = 1.78 ± 0.02 cm, CF = 1.76 ± 0.02 cm; $P = 0.53$), average LEA (NF = 42.57 ± 0.31 cm, CF = 42.14 ± 0.31 cm; $P = 0.21$), average HCW (NF = 87.28 ± 1.04 kg, CF = 88.19 ± 1.01 kg; $P = 0.21$) or average age at slaughter (NF = 203.81 ± 2.15 d, CF = 201.69 ± 2.07 d; $P = 0.23$) between treatments. There was no difference between treatments for growth or survival during the finishing stage. It was concluded that this crossfostering protocol was of little or no benefit to finishing performance at the commercial unit where this experiment was conducted.

Key Words: pigs, survival, crossfostering, growth

94 Effects of phase-feeding beef tallow on belly quality characteristics and yields of commercially-processed bacon from growing-finishing pigs fed dried distillers grains with solubles. N. A. Browne,* J. K. Apple, C. V. Maxwell, J. W. S. Yancey, T. M. Johnson, R. J. Stackhouse, and C. A. Keys, *University of Arkansas, Division of Agriculture, Department of Animal Science, Fayetteville.*

Crossbred pigs ($n = 216$) were used to test the effects of phase-feeding beef tallow (BT) on belly quality characteristics and yields of commercially-processed bacon from growing-finishing swine. Pigs were blocked by BW (26 ± 5.3 kg) and gender before allotment to pens (6 pigs/pen), and pens (6 pens/block) were allotted randomly to 1 of 6 dietary treatments. Dietary treatments consisted of a negative control (NC) devoid of BT for all phases; a positive control (PC) with 5% BT for all phases; or treatments including 5% BT during phases 1 and 2 (BT12), during phases 1, 2, and 3 (BT123), during phases 3, 4, and 5 (BT345), or during phases 4 and 5 (BT45). All dietary treatments were formulated with 30% dried distillers grains with solubles (DDGS) during phases 1, 2, and 3, 15% DDGS during phase 4, and no DDGS during phase 5. Pigs were slaughtered at a commercial pork packing plant (average BW of 124.1 kg). Fresh belly quality data was collected on the left-sided bellies, whereas bacon from the right-sided bellies was prepared under commercial processing conditions. Weights were recorded at all stages of processing, and yields were calculated as a percentage of the green belly weight. There was no ($P \geq 0.14$) effect of BT inclusion on fresh belly width, length, or average thickness. Bellies from the NC treatments tended to be less ($P = 0.08$) firm than bellies from the BT345, BT45, and PC treatments; but instrumental puncture test showed that mechanical firmness of bellies did not ($P \geq 0.38$) differ among treatments. Yield of commercially-processed bacon (pumped belly yield, smoked belly yield, and the percentage of number 1 bacon slices) was not ($P \geq 0.14$) affected by the dietary treatments. Results of this study indicated that phase-feeding BT to pigs fed diets formulated with DDGS had a tendency to improve fresh belly firmness but had no effect on yields of commercially-processed bacon.

Key Words: bacon, phase feeding, beef tallow, pork

95 The effects of alternative housing methods on gestating sow welfare. S. J. Gasca*¹, A. E. Dedecker², J. L. Salak-Johnson², P. M. Walker¹, and A. R. Hanson¹, ¹*Illinois State University, Normal*, ²*University of Illinois, Urbana.*

Growing public concern regarding welfare of gestating sows, as affected by housing environment, has increased the need for research evaluating sow housing alternatives. A 24-mo study was designed consisting of 6 trials involving 40 sows/trial to assess the effects of 3 housing systems; turnaround stalls (TS), straight stalls (SS) and loose housing in groups (LH) on sow well being. Only data from 3 trials will be reported. On d6 of gestation, sows were stratified by weight subject to variation in parity to either TS or SS. On d30 of gestation, sows remained in either TS or SS or were assigned to LH until d110 of gestation. Sows were evaluated for BCS, BW, and back fat (BF) on d 6, -29, -65, -90 and -110 of gestation. Sows were scored for total number and severity of lesions on d6 and then every 3rd day until d30; on d44 and every 3rd day until d58 and on d65, d76, d90 and d110 of gestation. Data were analyzed by SPSS procedures- with repeated measures. No differences ($P > 0.05$) in lameness scores were observed between d 30 and 110 of gestation among sows housed in SS, TS and LH. Similarly, no significant differences in BCS were observed among all treatment groups (mean = 3.0 on a 1–5 scale). Significant differences in lesion severity were observed with increasing severity, LH > TS > SS, comparing weighted scores of 26.88, 22.63 and 20.01, respectively. Total number of lesions were different, also with LH > TS > SS comparing weighted numbers of 43.25, 31.37 and 26.53, respectively. These data suggest that housing gestating sows in SS results in fewer lesions and lower lesion severity scores than housing sows in a TS or LH system and that a TS system may result in fewer and less severe lesions than a LH system.

Key Words: sow gestation, turnaround stall, straight stall, loose housing

96 Effect of inclusion of a *Saccharomyces cerevisiae* fermentation product in feedlot diets with two different sulfur concentrations. D. M. Paulus*¹, J. P. Jaderborg¹, C. Belknap², G. I. Crawford¹, and A. DiCostanzo¹, ¹*University of Minnesota, Saint Paul*, ²*Diamond V Mills, Cedar Rapids, IA.*

An experiment was conducted comparing the effects of a *Saccharomyces cerevisiae* fermentation product (XP, Diamond V Mills) in low- and high-sulfur (S) feedlot diets. Twenty-four Limousin steers and 24 Angus-cross steer calves (initial BW 290 ± 27 kg) were arranged in a randomized complete block design. Steers were individually fed in Calan gates and treatments were arranged in a 2×2 factorial, with 2 concentrations of dietary S (0.25%, LS; or 0.50%, HS) and XP (0 g/hd daily, NXP; or 56 g/hd daily, YXP). Steers, implanted with Synovex Choice on d 0 and Revalor 200 on d 87, were harvested after 174 d and HCW, marbling score, 12th rib fat thickness, LM area, USDA yield grade and quality grade were collected. Final carcass adjusted BW was not affected by S, XP, or their interaction ($P \geq 0.51$), and averaged 602 kg across treatments. Dry matter intake was not affected by S, XP, or their interaction ($P \geq 0.10$) and averaged 9.34 kg/d. Carcass adjusted ADG was not affected by S, XP, or their interaction ($P \geq 0.33$) and averaged 1.80 kg. A S x XP interaction was present for carcass adjusted gain:feed, ($P = 0.02$), with LS NXP being greater (0.211) than LS YXP, HS NXP, and HS YXP (0.185, 0.189, 0.194, respectively). No S x XP interactions were present ($P \geq 0.12$) for any carcass measurement. Percentage of carcasses grading USDA Select was not affected by S ($P = 0.59$); however, there was a trend ($P = 0.09$) for a decrease in percentage of carcasses grading USDA Select with XP inclusion, with 38.3% of carcasses from YXP grading Select compared with 62.5% from NXP. Marbling score, LM area, 12th rib fat thickness, and percentage USDA yield grade 2 and 3 carcasses were not affected ($P \geq 0.31$) by S concentration or XP inclusion. Results from this experi-

ment indicate that including XP in feedlot diets resulted in a trend for decreased percentage of USDA Select grading carcasses, but may also result in decreased feed efficiency in LS containing diets.

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

97 Effects of deleting crystalline amino acids from low-CP, amino acid-fortified diets and dietary valine:lysine ratio for nursery pigs from 6.8 to 11.3 kg. J. E. Nemecek¹, M. D. Tokach¹, S. S. Dritz¹, R. D. Goodband¹, J. M. DeRouchey¹, and J. L. Nelssen¹, ¹*Kansas State University, Manhattan*, ²*Ajinomoto Heartland, LLC, Chicago, IL*.

Two 14-d experiments were used to determine the effect of deleting crystalline amino acids from a low-CP, amino acid-fortified diet and the Val:Lys ratio required for optimal growth of nursery pigs. Diets were corn-soybean meal-based, contained 10% dried whey, and 1.30% SID Lys. For both trials, on d 3 after weaning, pigs were allotted to 1 of 6 dietary treatments. In both trials, 294 nursery pigs (PIC TR4 × 1050, initially 6.9 and 6.8 kg, respectively) were used with 7 pens per treatment and 7 pigs per pen. In Exp. 1 the positive control (PC) diet contained L-lysine HCl, DL-methionine, L-threonine, L-isoleucine, L-tryptophan, L-valine, L-glutamine, and L-glycine. The 6 treatments were (1) PC, (2) PC with L-isoleucine deleted, (3) PC with L-tryptophan deleted, (4) PC with L-valine deleted, (5) PC with L-glutamine and L-glycine deleted, and (6) PC with L-isoleucine, L-tryptophan, L-valine, L-glutamine, and L-glycine deleted from diet (NC). Amino acid:Lys ratios of the positive and negative control diets were: Ile (60 vs 52%), Trp (20 vs 15%), and Val (70 vs 57%). The Lys:CP ratios were 6.8 and 7.5%, respectively. The pigs fed the PC had improved ($P < 0.03$) ADG (303, 256, 246, 244 g) and ADFI (420, 367, 345, 345 g) compared with pigs fed diets with L-tryptophan or L-valine deleted or the NC, respectively. Compared with the PC there was no difference ($P > 0.40$) in ADG (303 vs 320 g), ADFI (420 vs 433 g), and G:F (0.72 vs 0.74) for pigs fed the diet with no L-isoleucine, and a tendency for decreased ($P < 0.19$) ADG (303 vs 277 g) and ADFI (420 vs 345 g) for pigs fed the diet with no L-glutamine and L-glycine. In Exp. 2, SID Val:Lys ratios tested were 57.4, 59.9, 62.3, 64.7, 67.2, and 69.6%. ADG (198, 238, 266, 292, 295, 298 g) and ADFI (316, 359, 418, 427, 440, 434 g) increased (quadratic, $P < 0.01$) and G:F (0.63, 0.67, 0.64, 0.69, 0.67, 0.69) improved (linear, $P < 0.02$) as the Val:Lys ratio increased from 57.4 to 64.7 with little improvement observed thereafter. These experiments demonstrated that L-tryptophan and L-valine were needed in the low-CP, high amino acid-fortified nursery diet, the Lys:CP ratio should be less than 7.5%, and a minimum Val:Lys ratio of 65% was required for optimal growth.

Key Words: amino acid, valine, nursery pig

98 Response by the modern lactating sow and progeny to source and level of supplemental dietary fat. D. S. Rosero¹, E. van Heugten¹, J. Odle¹, and R. D. Boyd², ¹*North Dakota State University, Department of Animal Sciences, Raleigh*, ²*Hanor Company, Inc., Franklin, KY*.

The objective of this study was to determine the response to increasing increments of 2 sources of dietary fat on sow and progeny performance during high ambient temperatures. Data were collected from 391 sows (PIC Camborough) from June to September in a 2,600-sow commercial unit in Oklahoma. Sows were assigned randomly to a 2 × 3 factorial arrangement and a control diet without added fat. Factors included: 1) fat sources: animal-vegetable blend (AV; 14.5% FFA, IV = 89, peroxide value: initial = 4.2, 4 h = 102, and 24 h = 140 mep/kg)

and choice white grease (CWG; 3.7% FFA, IV = 62, peroxide value: initial = 9.8, 4 h = 34, and 24 h = 228 mep/kg) and 2) fat level (2, 4 and 6%). Diets were corn-soybean meal based with 8.0% dried distillers grains with solubles and 6.0% wheat middlings, and contained 3.56 g standardized ileal digestible lysine/Mcal ME. Sows were balanced by parity, with 192, and 199 sows representing parity 1, and 3 to 5 (P3+), respectively. Feed refusal increased linearly ($P < 0.001$), but feed intake was not affected by additional fat. Caloric intake increased linearly ($P < 0.05$) with increasing fat. Sows fed CWG diets lost less body weight (0.04 kg/d) than either control sows (0.27; $P = 0.08$) or sows fed AV (0.20; $P = 0.10$). Litter growth rate was not affected by AV (1.97, 2.08, 1.99, and 2.07 kg/d; for 0, 2, 4, and 6%, respectively) but increased quadratically ($P < 0.05$) with CWG (1.97, 2.19, 2.04, and 2.00 kg/d). CWG improved G:F (sow and litter gain relative to feed intake; 0.51, 0.45, 0.52 for 2, 4, and 6%, respectively) compared with no fat (0.41; $P = 0.09$) and AV (0.44, 0.39, 0.36; $P < 0.01$). CWG, but not AV increased ($P < 0.05$) total fat content in the milk (subset of 30 sows; 6.30, 6.70, and 7.35% for control, 6% AV, and 6% CWG diets, respectively). Addition of CWG (67.0%) or AV (67.4%) improved ($P < 0.001$) the percentage of sows returning to estrus within 8 d after weaning compared with the control diet (56.0%). In conclusion, caloric intake increased with the addition of fat, but only CWG had a beneficial effect on litter growth rate, milk fat content, and G:F ratio. Return to estrus after weaning was improved by both fat sources.

Key Words: fat, lactation, sows

99 Protease inactivation by thermosonication and impact on milk characteristics. S. Vijayakumar,* D. Grewell, S. Jung, and S. Clark, *Iowa State University, Ames*.

Pasteurized milk shelf life is limited by heat-stable proteases, which cause bitterness and protein gelation. Ultra-high temperature processing inactivates proteases, but detrimentally affects milk quality. An alternative to pasteurization is sought to extend milk shelf life, while maintaining sensory properties. Ultrasonication has been used to inactivate microorganisms and various enzymes associated with food spoilage. In this study we are evaluating the effects of combined heat and ultrasound on the activity of bacterial (*Staphylococcus aureus*) protease and bovine plasmin, as well as impact on sensory properties and shelf life of milk. Pasteurized skim, reduced-fat and whole milk heated to 60°C and treated with ultrasound of amplitude 160, 170 and 180 μm for 1, 2 and 2.5 min showed significant decreases in the activity of *S. aureus* protease with increase in sonication amplitude ($P < 0.0001$) and time ($P < 0.0001$). A significant interaction between sonication amplitude and time on the protease activity was found ($P < 0.05$). No significant differences were observed in the rheological properties of milk samples that were thermosonicated at 180 μm for 2.5 min. However, off aromas were observed in reduced-fat and whole milk samples treated with 180 μm for 2.5 min. To investigate the impact of thermosonication on plasmin inactivation, thermosonication was conducted on pasteurized skim milk and heavy whipping cream at 60°C and 160, 180 and 200 μm for 1 to 3 min. The decrease in plasmin activity was not significant in skim milk; it was significant only for increase in amplitude ($P < 0.01$) in whipping cream. A significant interaction between sonication amplitude and time on protease activity was found in whipping cream only ($P < 0.01$). The effects of these treatments on the activity of native plasmin and plasminogen will be evaluated in raw milk and cream in the near future. Sensory panelists are being trained for quantitative descriptive analysis of milk odor attributes. Thermosonicated raw skim milk and raw cream aroma will be evaluated weekly, up to d 28. The outcome of this research will illu-

minate ultrasound's potential for applications in the dairy industry.

Key Words: milk, ultrasound, enzyme, quality

100 Effects of dietary tallow and DDGS on pork fat quality. J. M. Pomeroy¹, G. C. Shurson¹, S. K. Baidoo², and L. J. Johnston³, ¹University of Minnesota, St. Paul, ²Southern Research and Outreach Center, Waseca, MN, ³West Central Research and Outreach Center, Morris, MN.

A study was conducted to determine if supplementing beef tallow to grower-finisher diets containing corn dried distillers grains with solubles (DDGS) would reduce the negative effects of DDGS on pork fat firmness. Crossbred pigs (n = 315) were blocked by initial BW (32.4 ± 1.9 kg) and assigned randomly to 1 of 4 dietary treatments in a 3-phase feeding program using a 2 × 2 factorial arrangement of treatments. Diets consisted of a conventional corn-soybean meal diet (C), C containing 30% DDGS (D), C containing 5% tallow (T), and C with 30% DDGS and 5% tallow (DT). Pigs were housed in a confinement facility containing 40 pens with 7 to 8 pigs per pen to provide 10 replications per treatment. Gilts and barrows were housed separately, but fed common diets formulated to contain similar available P and Standardized Ileal Digestible Lys:ME across treatments. For fat quality characteristics, one pig from each pen was selected based being the closest to average pen BW (n = 20 barrows and 20 gilts). Data were analyzed utilizing the Proc Mixed functions of SAS with random effect of block and fixed effects of DDGS, tallow, gender, and DDGS × tallow. Hunter L* and b* values for backfat and belly fat were greater (P < 0.01) for pigs fed C and T diets compared with pigs fed D and DT. Similarly, Japanese Color Score for belly fat was higher (P < 0.03) for pigs fed D and DT. Pigs fed D and DT exhibited softer bellies based on a lower

belly flop angle (P < 0.01) compared with pigs fed C and T. An interaction (P < 0.03) between DDGS and tallow was observed for belly fat iodine value (IV), indicating that tallow decreases IV when DDGS was included in the diet, but tallow increased IV when no DDGS was included. Backfat IV increased (P < 0.01) when either DDGS or tallow were fed. In conclusion, adding 5% tallow to diets containing 30% DDGS did not improve pork fat firmness.

Table 1. Tallow and DDGS effects on belly firmness and fatty acids in pork fat

							P value	
	C	T	D	DT	PSE	DDGS	TALLOW	DDGSx TALLOW
Belly Flop, °	125.8	115.3	72.6	63.1	9.9	<0.01	NS	NS
Belly Fat								
PUFA, %	8.6	8.5	15.4	11.4	1.8	<0.01	NS	NS
MUFA, %	51.1	57.5	43.8	56.2	3.2	NS	<0.01	NS
SFA, %	40.3	34.1	30.8	32.4	2.1	<0.01	<0.01	NS
IV	59.0	64.2	71.2	67.9	1.9	<0.01	NS	<0.03
Backfat								
PUFA, %	8.9	9.9	16.3	18.5	1.3	<0.01	NS	NS
MUFA, %	23.5	27.6	14.4	23.7	1.8	<0.01	<0.01	NS
SFA, %	43.2	38.0	37.9	33.1	2.9	NS	<0.01	NS
IV	56.7	61.9	65.3	73.6	2.2	<0.01	<0.01	NS

Key Words: DDGS, tallow, pork fat quality

Graduate Student Oral Competition—Ph.D.

101 Effect of sow omega-3 fatty acid supplementation on growth performance of piglets from low birth weight litters. M. N. Smit¹, J. D. Spencer², S. A. Crowder², J. L. Patterson¹, F. Aarsse¹, and G. R. Foxcroft¹, ¹University of Alberta, Edmonton, AB, Canada, ²JBS United Inc., Sheridan, IN.

Multiparous sows with a low litter birth weight phenotype were matched at weaning by parity and average birth weight of their last 3 litters, and designated as controls (CON; n = 81), fed standard gestation and lactation diets, or treated (GRO; n = 82), fed standard gestation and lactation diets supplemented with 0.48% of a marine-oil based supplement rich in eicosapentaenoic and docosahexaenoic acid (O3FA; Gromega, JBS United Inc.). Number of pigs born and weaned, and individual pig weight at birth and weaning, were recorded. From each of 4 breeding groups, the 6 lowest average birth weight litters of each treatment (n = 24/trt) were weaned and strategically allocated across treatments by litter birth weight ranking into adjacent pens in nursery rooms with 24 pens, 3–6 pigs/pen and 1 or 2 pens per litter. Average pen weight and feed intake in the nursery were recorded at 0, 1, 3 and 5 wks and ADG, ADFI and Gain/Feed was calculated for wk 1 (period 1), wks 2–4 (period 2) and wks 3–5 (period 3). Data were analyzed with a repeated measures analysis with nested design using the mixed models procedures in SAS. Litter size was greater (P

< 0.05) for CON than GRO sows (12.3 ± 0.4 vs. 10.9 ± 0.4 born alive, respectively). Litter average body weight was similar between treatments at birth and weaning, but gradually diverged during the nursery phase to become greater (P < 0.05) in GRO than CON litters at the end of period 3 (18.21 ± 0.34 vs. 17.28 ± 0.33 kg, respectively), associated with a trend (P < 0.10) for higher ADG (0.51 ± 0.01 vs. 0.48 ± 0.01 kg, respectively) and ADFI (0.72 ± 0.01 vs. 0.69 ± 0.01 kg, respectively) in period 3 in GRO litters. A decreased litter size at birth in O3FA supplemented sows is not consistent with previous research. However, this study supports the hypothesis that O3FA supplementation to sows with lower average birth weights will improve the post-natal growth performance of their offspring.

Key Words: birth weight, growth, omega-3 fatty acids, pigs

102 Meta-analyses to improve prediction of pork carcass fat quality. J. R. Bergstrom,* M. D. Tokach, J. L. Nelssen, S. S. Dritz, R. D. Goodband, J. M. DeRouchey, and T. A. Houser, Kansas State University, Manhattan.

Largely because of the increased availability and use of dried distillers grains in swine diets, concerns over quality of pork fat as mea-

sured by iodine value (IV) have increased. Data indicates that, within experiment, regression equations are highly accurate to predict pork fat IV based on dietary IV product (IVP) or polyunsaturated fatty acids (PUFA), such as C18:2. However, experiences in the field indicate that these predictions are not as accurate when applied to different genetic lines or environmental conditions. This implies that other factors beside diet IVP value are contributing significant amounts of variation and reducing the accuracy of the prediction. Therefore, 2 meta-analyses were performed to identify variables that may improve the accuracy of pork fat IV value prediction equations. The first analysis used data from 21 experiments where pigs were fed a relatively constant dietary IVP and the second analysis used 6 experiments where pigs were fed a dietary IVP-reduction strategy. As expected, dietary concentration of PUFA was the most important prediction factor. However, models were improved by including variables to describe initial and final BW, ADG, and carcass leanness. Increased ADG, final BW, BW range over course of the diet, and backfat depth resulted in reduced backfat IV ($P < 0.02$). Belly fat IV was reduced with increasing final BW, BW range over the course of the diet, and backfat depth ($P < 0.03$). Reduced jowl fat IV was associated with an increase in backfat depth and a lower fat-free lean index (FFLI, $P < 0.02$). The R^2 of the equation for jowl fat IV improved from 0.45 when including only diet IVP to 0.75 when including other variables (jowl fat IV = $2.70 + 0.18 \times \text{diet IVP} + 2.15 \times \text{diet C18:2}(\%) - 0.33 \times \text{diet ME from fat}(\%) + 1.10 \times \text{FFLI}$). Reducing diet PUFA in the initial and diet just before marketing led to lower fat IV, indicating that increasing the length and magnitude of dietary IVP-reduction strategy resulted in the greatest fat IV value reductions. The IV of backfat was most amenable to change using an IVP-reduction strategy. Feeding pigs for a longer period and heavier final BW resulted in a reduced backfat IV ($P \leq 0.05$). These results indicate that including variables besides diet IVP or C18:2 greatly improved the ability to predict IV of pork fat.

Key Words: fatty acids, fat quality, iodine value, prediction equations

103 Enterosorption therapy provided by Calibrin-Z when pigs were fed low zearalenone concentrations. J. P. Wang^{*1}, I. H. Kim¹, S. W. Choi², J. Broomhead³, and F. Chi³, ¹Dankook University, Department of Animal Resource & Science, Cheonan, Choongnam, South Korea, ²CTCBio, Seoul, South Korea, ³Amlan International, Chicago, IL.

A total of one hundred and 40 4 gilts with an initial BW of 8.16 ± 1.27 kg were used in the study. Pigs were fed a common corn-soybean meal based diet for a 7 d adjustment period, then randomly allotted to 8 treatments according to their BW (3 replicate pens with 6 pigs each) and fed test diets for 28 d. Cultured corn meal contaminated with 180 mg/kg of zearalenone (ZEA, University of Missouri, Columbia) and a clay enterosorbent Calibrin-Z (Amlan International, Chicago) were used in the formulation to achieve increasing ZEA and clay concentrations in test diets while maintaining a consistent clay to toxin ratio between treatments (Table 1). Blood samples were collected on d-14 and d-28 and serum malondialdehyde (MDA), superoxide dismutase (SOD), and liver enzymes such as aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (AP) were analyzed. Pigs fed 800 ppb ZEA diet showed a worse ADG and FE ($P < 0.05$) as compared with the pigs fed 0 ppb ZEA diet. Addition of 0.2% Calibrin-Z to the 800 ppb ZEA diet improved ($P < 0.05$) FE. The vulva size of pigs increased linearly ($P < 0.05$) as dietary ZEA increased. Addition of Calibrin-Z reduced ($P < 0.05$) average vulva size in the 400 and 800 ppb ZEA treatments but not in 0 and 200 ppb ZEA treat-

ments. DM, CP and GE digestibility decreased ($P < 0.05$) as dietary ZEA increased and were all improved by Calibrin-Z supplementation and the improvement was independent of dietary ZEA dosage. Serum liver enzymes increased linearly as dietary ZEA increased on d-14 but not on d-28. Serum MDA increased and SOD decreased as dietary ZEA dosage increased ($P < 0.05$), and Calibrin-Z supplementation reversed the effects that ZEA had on serum MDA and SOD activity. The study demonstrated that, besides its estrogenic effect, feeding relative low ZEA concentrations reduced nutrient digestibility, increased oxidative stress and affected pig' growth. Addition of Calibrin-Z to ZEA contaminated feeds and maintaining a 2,500:1 binder to toxin ratio can effectively ameliorate the negative effects of ZEA.

Table 1 – Experimental treatments

Treatment	1	2	3	4	5	6	7	8
ZEA, μppb	0	0	200	200	400	400	800	800
Calibrin-Z, %	0	0.20	0	0.05	0	0.10	0	0.20

Key Words: zearalenone, oxidative stress, clay enterosorbent, pigs

104 Effects of including low fat dried distillers grains in finishing diets on feedlot performance and carcass characteristics of beef steers. J. M. Kelzer^{*1}, J. M. Popowski¹, S. Bird², R. Cox¹, G. I. Crawford³, and A. DiCostanzo¹, ¹University of Minnesota, St. Paul, ²University of Minnesota, North Central Research and Outreach Center, Grand Rapids, ³University of Minnesota Extension, Hutchinson.

Angus steers (n = 48) averaging 317 ± 8 kg initial BW were used to evaluate effects of partially replacing dry-rolled corn (DRC) with conventional dried distillers grains plus solubles (27.6% CP, 10.9% fat) or low fat dried distillers grains (39.0% CP, 5.0% fat) in traditional DRC-based finishing diets on feedlot performance and carcass characteristics. Steers were assigned randomly to one of 3 finishing diets (DM-basis): 1) 82.5% DRC, 12.1% CP, 3.55% fat, 0.15% S, 1.29 Mcal/kg NE_g (CON); 2) 35% conventional dried distillers grains plus solubles, 17.1% CP, 5.96% fat, 0.42% S, 1.29 Mcal/kg NE_g (DDGS); or 3) 35% low fat dried distillers grains, 22.0% CP, 3.53% fat, 0.37% S, 1.26 Mcal/kg NE_g (LFDG). Diets contained 12% alfalfa haylage and supplied 300 mg monensin sodium/steer daily. Steers were fed *ad libitum* once daily at 0700 using individual Calan gates. On d -11 and 56, respectively, steers received initial and terminal implants (Synovex[®] Choice). On d 118, steers were harvested at a commercial abattoir and carcass characteristics were collected. Carcass-adjusted final BW was similar ($P = 0.54$) and averaged 553, 552, and 540 ± 9 kg for CON, DDGS, and LFDG, respectively. Overall DMI tended to be greater ($P = 0.08$) for CON compared with LFDG (10.3 vs. 9.7 ± 0.2 kg/d) but was similar ($P = 0.58$) to DDGS (10.2 kg/d). However, DMI from d 28 through finishing was greater ($P < 0.01$) for CON than LFDG (10.8 vs. 9.9 ± 0.2 kg/d) but was similar ($P = 0.16$) to DDGS (10.5 kg/d). Carcass-adjusted ADG and gain:feed were similar ($P \geq 0.49$) among treatments and averaged 1.98, 1.99, and 1.91 ± 0.05 kg and 0.192, 0.196, and 0.197 ± 0.004 for CON, DDGS, and LFDG, respectively. Hot carcass weight, yield grade, 12th rib backfat, LM area, and marbling score were similar ($P \geq 0.18$) among treatments. Percent carcasses grading USDA Prime and Choice were similar ($P = 0.86$) and averaged 81.3, 87.5, and $81.3 \pm 9\%$ for CON, DDGS, and LFDG. Finishing beef cattle with low fat dried distillers grains tended to reduce overall DMI; however, it may successfully replace conventional dried distillers grains or up to 35% DRC in feedlot diets without negatively affecting other live performance or carcass characteristics.

Key Words: dried distillers grains, feedlot performance, beef steers

105 The effect of dam parity (1 vs 3) on litter performance, passive immunity, and fecal microbial fingerprinting. E. E. Hinkle,* H. Tran, J. W. Bundy, P. S. Miller, and T. E. Burkey, *University of Nebraska, Lincoln*.

Previous research has shown that parity (P) 4 progeny have greater weaning weights and increased concentrations of serum immunoglobulin (Ig) G. The objective of this experiment was to evaluate litter performance, passive immunity, and fecal microbiota among P1 (n = 56) and P3 (n = 49) dams and their progeny. Blood samples were collected from P1 and P3 dams on d 90 and 114 of gestation and d 0 of lactation and from their progeny (n = 4 pigs/litter) post parturition on d 0, 7, and 14. Milk samples were collected from dams on d 0, 7, and 14 of lactation. Fecal samples were collected from dams (d 7) and their progeny (n = 4 pigs/litter; d 0, 7, and 14) of lactation. Serum and milk samples were analyzed for Ig (G and A) concentrations via ELISA. Microbial fingerprinting of fecal samples from dams and progeny were performed via DGGE. No differences were observed between parities in total born, live born, mummies, deaths, or total weaned; however, P3 dams had a greater number of stillborns ($P < 0.013$) compared with P1 dams (1.0 and 0.5 Pigs, respectively). Litter BW was increased for P3 litters on d 0, 7, 14, and at weaning (d 16) compared with P1 dams ($P < 0.001$; 14.6 and 18.4, 23.0 and 28.9, 38.9 and 48.0, 43.8 and 57.2 for P1 and P3 by day, respectively). Dam serum IgG concentrations on d 114 of gestation were increased ($P < 0.001$) for P3 dams compared with P1 dams. No effects of dam parity were observed for IgA. Dam serum ($P = 0.56$) or for milk Ig (G and A) concentrations ($P > 0.40$). Parity \times day interactions were observed for progeny IgG ($P < 0.01$) and IgA ($P < 0.001$) concentrations. Progeny derived from P3 dams had greater concentrations IgG on d 0 and 14 compared with P1 progeny, and IgA concentrations were greater in P3 progeny on d 0. There were no effects of dam parity on fecal microbial fingerprinting (diversity or similarity indices) in samples obtained from dams or their progeny ($P > 0.50$). Litter performance and transfer of passive immunity may be affected by dam parity.

Key Words: swine, parity, passive immunity, gut microbiota

106 Effects of corn dried distillers grains with solubles (DDGS) on diet digestibility and slurry output from gestating sows. X. J. Li*¹, S. K. Baidoo², G. C. Shurson¹, and L. J. Johnston³, ¹*University of Minnesota, Saint Paul*, ²*Southern Research and Outreach Center, Waseca, MN*, ³*West Central Research and Outreach Center, Morris, MN*.

An experiment was conducted to evaluate the effects of feeding diets containing high level of DDGS to sows for 3 reproductive cycles on nutrient digestibility, and quantity and composition of slurry output. A total of 40 sows at parity 0 or 1 were assigned randomly to 1 of 2 dietary treatments and maintained on these treatments for up to 3 reproductive cycles. Sows were fed either a fortified corn-soybean meal control diet (C) during gestation and lactation, or a diet containing 40% DDGS in gestation and 20% DDGS in lactation (D). Concentrations of CP (14.9 vs. 15.0%) and available P (0.41 vs. 0.43%) of C and D diets during gestation were similar. During wk 6 to 10 of gestation, total collection of feces and urine was performed for 3 d on sows in their first or third reproductive cycle from C (n = 9 vs. n = 10, respectively) and D (n = 10 vs. n = 11, respectively) to determine apparent DM digestibility of diets. Fecal and urinary subsamples from each sow were mixed in the same proportion as excreted to simulate slurry production, and were analyzed for N, P, and K content. There were no interactions between diet and reproductive cycle. Neither diet nor reproductive cycle affected ADFI of sows. Feeding D decreased ($P < 0.05$) diet DM

digestibility compared with C (76.7% vs. 82.9%, respectively; SE = 3.34). Sows fed D excreted more ($P < 0.05$) fresh feces than sows fed C (755 vs. 561 g/d, respectively; SE = 93.12). Neither fecal moisture content (39.4% vs. 37.9%; SE = 1.47) nor volume of slurry (4.0 vs. 4.5 L; SE = 0.90) excreted daily were different between sows fed C or D, respectively. Quantity of N (35.0 vs. 34.4 kg; SE = 3.76) and P (28.4 vs. 29.2 kg; SE = 4.23) per 3,800 L of excreted slurry were not different between C and D, respectively. Amount of K excreted per 3,800 L of slurry was not affected by diet or reproductive cycle. In conclusion, feeding diets containing 40% DDGS to gestating sows decreased apparent DM digestibility of the diet and increased the fecal output but did not affect the total volume of slurry produced or N, P, or K output in slurry.

Key Words: DDGS, sows, diet digestibility, slurry

107 Effects of dietary clays on diarrhea of weaned pigs experimentally infected with a pathogenic *E. coli*. M. Song*¹, Y. Liu¹, J. A. Soares¹, T. M. Che¹, O. Osuna², C. W. Maddox¹, and J. E. Pettigrew¹, ¹*University of Illinois, Urbana*, ²*Milwhite, Inc., Brownsville, TX*.

A previous study from our lab indicated a clay, smectite, reduced diarrhea of weaned pigs. The present study tested whether 3 different clays reduce diarrhea of weaned pigs experimentally infected with a pathogenic *E. coli*. Pigs (n = 128, 6.7 \pm 0.8 kg BW; 2 replicated groups) were housed in individual pens in disease-containment chambers for 16 d (4 d before and 12 d after the first challenge (d 0)). Treatments were in a factorial arrangement: with or without a F-18 *E. coli* challenge (toxins: LT, STb and SLT-2; 10¹⁰ cfu/3 mL oral dose; daily for 3 d from d 0) and 8 diets (a nursery basal diet (CON) and 7 clay diets (0.3% smectite, kaolinite, or zeolite individually, or all combinations to total 0.3%)) without antibiotics, spray-dried plasma, or zinc oxide. Measurements were growth performance (d 0 to 6, 6 to 12, and 0 to 12), daily diarrhea score (DS; 1 = normal, 5 = watery diarrhea), frequency of diarrhea (FD; % of pig days with DS of 3 or higher), ratio of β -hemolytic coliforms to total coliforms (RHT; d 0, 3, 6, 9, and 12) by plating feces on blood agar and assessing the populations visually using a score (0 = no growth, 8 = very heavy growth), and total and differential white blood cell counts (WBC) as well as packed cell volume (PCV) and total serum protein (TP) as indicators of dehydration (d 0, 6, and 12). In the *E. coli* challenged group, the clay treatments reduced overall DS (1.6 vs. 3.0; $P < 0.05$) and FD (21 vs. 71%; $P < 0.05$), RHT (d 9: 0.32 vs. 0.76; $P < 0.05$, d 12: 0.13 vs. 0.39; $P = 0.09$), and total WBC (d 6: 15 vs. 18 $\times 10^3/\mu\text{l}$; $P = 0.07$) compared with the CON, but did not affect growth rate. There were no consistent differences among the clay treatments. The *E. coli* infection reduced ($P < 0.05$) overall ADG (235 vs. 336 g/d) and ADFI (707 vs. 788 g/d), and increased ($P < 0.05$) overall DS (1.8 vs. 1.3) and FD (27 vs. 5%), RHT (d 3: 1.00 vs. 0.09, d 6: 0.94 vs. 0.18), total WBC (d 6: 16 vs. 13 $\times 10^3/\mu\text{l}$), PCV (d 6: 36 vs. 34%), and TP (d 6: 4.9 vs. 4.6 g/dL) compared with the unchallenged group. In conclusion, the clays tested alleviate diarrhea of weaned pigs experimentally infected by a pathogenic *E. coli*.

Key Words: clay, diarrhea, weaned pigs

108 Effect of heat stress on oxidative stress status and reproductive performance of sows. Y. Zhao*¹, W. L. Flowers¹, A. Saraiva^{1,2}, K.-J. Yeum³, and S. W. Kim¹, ¹*North Carolina State University, Raleigh*, ²*Universidade Federal de Viçosa, Viçosa, MG, Brazil*, ³*Tufts University, Boston, MA*.

This study was aimed to determine effects of heat stress on oxidative status, and reproductive performance of sows during gestation and lactation. Fourteen sows were housed under moderate ambient temperature environment (CON: daily range of 17.8 ± 1.3 to $11.8 \pm 1.4^\circ\text{C}$ during gestation and 23.0 ± 0.6 to $20.0 \pm 0.4^\circ\text{C}$ during lactation) and another 14 sows were housed under high ambient temperature environment (HT: daily range of 29.7 ± 1.0 to $21.3 \pm 0.9^\circ\text{C}$ during gestation and 30.3 ± 0.4 to $23.3 \pm 0.3^\circ\text{C}$ during lactation). Sows were fed corn-soybean meal based diets during gestation (2.2 kg/d) and lactation (ad libitum). Backfat thickness, BW, and blood samples were obtained on d 35, 60, 90, and 109 of gestation, and d 1 and 18 of lactation. Litter weight and piglet BW were obtained on d 1 and 18 of lactation. Plasma was used to determine concentrations of malonaldehyde (MDA), protein carbonyls (PCS), 8-hydroxy-deoxyguanosine (8OHdG), and immunoglobulins (Ig) G and M. Sows in HT had reduced ($P < 0.05$) litter size and litter weight at birth and d 18 of lactation as well as reduced ($P < 0.05$) litter weight gain than sows in CON. Sows in HT had greater ($P < 0.05$) plasma MDA on d 90 and 109 of gestation, and d 1 of lactation than sows in CON. Sows in HT had greater ($P < 0.05$) plasma PCS on d 90, 109 of gestation and d 1 and 18 of lactation than sows in CON. Plasma 8OHdG and PCS were greater ($P < 0.05$) on d 108 of gestation than those on other days for sows in HT. Sows in HT had greater ($P < 0.05$) IgG and M in colostrum than sows in CON. Plasma IgG of sows in HT tended to be greater ($P = 0.067$) than sows in CON on d 3 of lactation. Collectively, sows are under elevated oxidative stress during late gestation and lactation when they are housed in a heat stress environment. Increased oxidative damage to lipid, protein, and DNA is one of the major contributing factors for reduced reproduction performance of sows under heat stress.

Key Words: heat stress, oxidative stress, sow

109 Immunological status and metabolite profile of newborn dairy calves when respective dams were fed a stepwise moderate energy diet or a controlled energy diet during the dry period. J. S. Osorio^{*1}, P. Ji¹, G. Invernizzi^{1,2}, J. K. Drackley¹, and J. J. Loores¹, ¹University of Illinois, Urbana, ²University of Milan, Milan, Italy.

Decreases in dry matter intake and increases in concentrations of non-esterified fatty acids and cortisol during the periparturient period have been associated with an impaired immunological status in dairy cows. Controlling energy intake during the dry period has been proposed to diminish these conditions. The extent of these effects on the immunological status of newborn calves is unknown. Holstein cows ($n = 12$) were randomly assigned to a stepwise moderate energy (ME) diet (1.49 Mcal/kg) or a controlled energy (CE) diet (1.30 Mcal/kg) during the close-up period (-21 to 0 d relative to calving). All cows were fed CE during the far-off period (-50 to -21 d relative to calving). At birth, calves were separated from dams and during the first 6 h received at least 3.8 L of dam's colostrum with >60 mg/dL of solids density. Blood samples were taken at birth (Pre-colostral), 48 h (Post-colostral), 1 wk, 5 wk, and 6 wk. Gene expression patterns also were determined for PMN isolated from blood samples. Whole blood phagocytosis was assessed through flow cytometry (BD Biosciences LSR II). Data were analyzed using the MIXED procedure of SAS (v. 9.2). Treatment effects did not affect albumin, total protein, or IgG concentrations. Non-esterified fatty acids concentration decreased sharply 48 h post-colostrum. Glucose concentration was greater ($P = 0.05$) 48 h post-colostrum for calves from ME cows. There was a tendency for a treatment*time ($P = 0.13$) for insulin concentrations where ME calves tended to have increased insulin, compared with CE calves. Whole blood phagocytosis decreased by ~50% from 48 h to 1

wk post-colostrum. A tendency for greater whole blood phagocytosis ($P = 0.14$) and greater ($P = 0.06$) response for neutrophils phagocytosis was observed in ME calves. Neutrophils percentage of total leukocytes decreased ($P < 0.01$) as calves grew, while monocytes increased ($P = 0.01$) regardless of dams' treatments. Nutrient status of the cow during late gestation could impact immunological status of the newborn calf, although the mechanisms are not known.

Key Words: calves, phagocytosis, immunology

110 Effects of haylage and monensin on ruminal metabolism of cattle fed 60% DDGS diets. T. L. Felix^{*} and S. C. Loerch, *The Ohio State University, Wooster.*

Excess production of hydrogen sulfide gas (H_2S) in the rumen causes polioencephalomalacia. Availability of free hydrogen ions and the production of H_2S may be affected by ruminal pH and monensin supplementation. High dietary inclusion of dried distillers grains with solubles (DDGS) increases the S content of feedlot cattle diets and exacerbates this problem. The efficacy of forage (to increase ruminal pH) and monensin supplementation to cattle on high DDGS diets to reduce ruminal H_2S production has not been investigated in vivo. The objectives of this study were to determine the effects of monensin and haylage supplementation on ruminal pH, H_2S , and organic acids. Eight ruminally fistulated steers (BW = 346 ± 34 kg) were used in a replicated 4×4 Latin Square design and randomly assigned to 1 of 4 treatments in a 2×2 factorial arrangement: 1) 0 mg monensin/kg diet and 0% haylage, 2) 33 mg monensin/kg diet and 0% haylage, 3) 0 mg monensin/kg diet and 10% haylage, and 4) 33 mg monensin/kg diet and 10% haylage. The remainder of the diet was 60% DDGS, 10% corn silage, 15% supplement, and corn (5 or 15%) on a DM basis. Haylage inclusion increased ruminal pH from 1.5 through 12 h post-feeding and the effects of monensin supplementation were additive (interaction: $P < 0.05$). Rumen pH dropped within 1.5 h post-feeding to 5.16, 5.35, 5.60 and 5.73, for diets 1 to 4, respectively, and continued to decrease through 12 h post-feeding. From 1.5 through 9 h post-feeding, steers fed 33 mg monensin/kg diet tended to have reduced ($P \leq 0.10$) concentrations of H_2S when compared with steers fed 0 mg monensin/kg diet. Acetate:propionate ratio at 6 h post-feeding was 0.94, 0.93, 1.29, and 1.35 for diets 1 to 4, respectively (interaction: $P < 0.01$). Total lactate was low, regardless of treatment, at 6 h post-feeding (range: 0.94 to 1.42 $\mu\text{mol/mL}$). Sulfuric acid in DDGS and not organic acid production may be responsible for the low rumen pH observed and may influence the maximum inclusion of DDGS in cattle diets. Monensin supplementation decreased H_2S concentration and may decrease the risk of polioencephalomalacia for cattle fed high DDGS diets.

Key Words: dried distillers grains, monensin, beef cattle, sulfur

111 Crystalline amino acid inclusion in a reduced-crude protein diet increases mammary arginine and lysine apparent utilization and maintains sow performance independently of amino acid transporter gene expression. R. Manjarin^{*1}, V. Zamora², G. Wu⁴, N. Am-in³, J. P. Steibel¹, R. N. Kirkwood¹, N. P. Taylor¹, J. Liesman¹, K. Trifilo¹, and N. L. Trottier¹, ¹Michigan State University, East Lansing, ²Colegio de Postgraduados, Montecillo, Mexico, ³Chulalongkorn University, Bangkok, Thailand, ⁴Texas A&M University, College Station.

To test the hypothesis that reduction in dietary CP% coupled with crystalline (C) AA inclusion increases the efficiency of AA utilization for milk production, mammary AA arterio-venous difference concentra-

tions (A-V), extraction rate (ER = A-V/A) and transcript abundance of AA transporters and milk proteins-encoding genes were determined in lactating sows fed 1 of 3 diets containing 10.7 (deficient), 15.1 (ideal), and 19.4% (standard) CP and a similar indispensable and dispensable AA profile. On d 7 and 17, arterial and mammary venous blood and mammary tissue were sampled post feeding. Transcript abundance of AA transporters SLC7A9 ($b^{0,+}AT$), SLC7A6 (y^+LAT2), SLC6A14 ($ATB^{0,+}$), SLC7A1 (CAT-1), and SLC7A2 (CAT-2b), and milk proteins CSN2 (β -Casein) and LALBA (α -Lactalbumin) was determined using qPCR. Piglet ADG increased curvilinearly with increasing % CP (Q (quadratic), $P < 0.01$), and was lower ($P < 0.05$) for deficient compared with ideal and standard diets, and did not differ between ideal and standard diets. Lysine and Arg A-V and ER increased curvilinearly (Q, $P = 0.03$) on d 7, and Lys A-V tended to increase linearly (L) (L, $P = 0.08$) on d 17 with increasing % CP. Compared with deficient and standard diets, Arg A-V was higher ($P < 0.01$) and ER tended to be higher ($P = 0.09$) for ideal diet on d 7. Increasing CP linearly increased Ile and Val A-V on d 7 (L, $P = 0.05$ and $P = 0.07$, respectively) and Val and Leu on d 17 (L, $P = 0.08$ and $P = 0.04$, respectively). Transcript abundance of CAT-1, CAT-2b, $ATB^{0,+}$, $b^{0,+}AT$, y^+LAT2 , CSN2 and LALBA was unaffected by diet. In conclusion, decreasing % CP to 15.1 with inclusion of CAA increased mammary Arg A-V and ER and decreased Leu, Ile and Val A-V without affecting ADG nor AA transporter and milk protein gene transcript abundance. These results indicate that CP reduction with CAA inclusion improves the efficiency of dietary AA utilization for litter growth via mechanisms independent from AA transporter or milk protein gene transcription.

Key Words: amino acid, sow, mammary gland, lactation

112 Genetic parameters and markers associated with viremia and growth in pigs infected with porcine reproductive and respiratory virus. N. Boddicker^{*1}, D. J. Garrick¹, J. M. Reecy¹, B. Rowland², M. F. Rothschild¹, J. P. Steibel³, J. K. Lunney⁴, and J. C. M. Dekkers¹, ¹Iowa State University, Ames, ²Kansas State University, Manhattan, ³Michigan State University, East Lansing, ⁴USDA, ARS, BARC, Beltsville, MD.

Porcine Reproductive and Respiratory Syndrome (PRRS) is one of the most costly diseases in pigs. The objective of the current study was to conduct a genome-wide association study to discover the genetic basis of host response to PRRS virus using data from the PRRS Host Genetics Consortium PRRS-CAP project. Three groups of 200 commercial crossbred pigs were infected with PRRS virus isolate NVSL 97-7985 between 18 and 28 d of age. Blood samples and body weights were collected up to 42 d post infection (pi). Pigs were genotyped with the Illumina Porcine 60k Beadchip. Whole genome analyses focused on viremia and weight gain. Viremia was quantified using area under the curve (AUC) for log-transformed RT-PCR based serum virus between d 0 and 21 pi, and body weight gain (WG) from d 0 to 42 pi. Heritabilities were estimated using a sire and dam model, with trial, parity, and their interaction as fixed factors, and sire, dam within sire, and pen within trial as random factors. Heritabilities for AUC and WG were 0.31 and 0.19 based on the sire variance, while the dam component indicated substantial maternal or litter effects. Associations with SNPs were identified using method Bayes-C-pi of the Gensel software. Using Porcine sequence build 10, regions on chromosomes 1, 4, 5, 11, and 16 were found to be associated with AUC and regions on 1, 4, 7, and 17 with WG. These results indicate a substantial host genetic component in response to infection with the PRRS virus and that selection for resistance, susceptibility, or tolerance is possible. Further work will examine biological significance of identified regions. This work is supported by the PRRS CAP, USDA NIFA Award 2008-55620-19132

and the NRSP-8 Swine Genome and Bioinformatics coordination projects.

Key Words: PRRS, swine, genetic parameters, markers

113 Maternal exercise alters fetal amino acids in pigs. T. A. Wilmoth^{*1}, E. K. Harris², T. L. Neville², E. P. Berg², K. A. Vonnahme², and M. E. Wilson¹, ¹West Virginia University, Morgantown, ²North 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). The objective of this study was to determine the effects of exercise in second parity sows on fetal development and metabolism. 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 umbilical blood (arterial and venous) and amniotic fluid samples were obtained from 3 fetuses from each horn (tip, middle or base). Fetal and organ weights were recorded. Umbilical blood samples (reported as veno-arterial (VA) difference) and amniotic fluid were used for the determination of amino acid concentrations. Fetal (736 ± 30 vs 625 ± 35 g), liver (16 ± 0.6 vs 13 ± 0.7 g) and semimembranosus (4.7 ± 0.2 vs 3.6 ± 0.2 g) weights were decreased ($P < 0.05$) in fetuses of exercised dams. In the amniotic fluid, proline (16.7 ± 0.8 vs 14.7 ± 0.4 µg/mL) and ethanolamine (1.7 ± 0.2 vs 1.1 ± 0.2 µg/mL) were decreased ($P < 0.05$) in fetuses from exercised dams, while methionine (1.0 ± 0.2 vs 2.1 ± 0.5 µg/mL) and cystine (2.8 ± 0.2 vs 3.5 ± 0.2 µg/mL) were increased ($P < 0.05$) in fetuses from exercised dams compared with control. The VA difference for methionine (-0.24 ± 0.03 vs 0.51 ± 0.39 µg/mL), leucine (-1.21 ± 0.07 vs 2.15 ± 0.39 µg/mL), lysine (-1.24 ± 0.26 vs 2.89 ± 2.91 µg/mL) and arginine (-1.11 ± 0.2 vs 2.33 ± 1.9 µg/mL) were increased ($P < 0.05$) in those fetuses whose dams were in the exercise group, while the VA difference in citrulline (0.78 ± 0.19 vs -1.53 ± 0.91 µg/mL) and glutamic acid (36.04 ± 4.04 vs 16.46 ± 2.54 µg/mL) were decreased ($P < 0.05$) in fetuses of exercised dams compared with control. Exercising sows during gestation increased the VA difference of some amino acids indicating a more efficient usage of those amino acids by the fetus at a time when muscle development is still occurring, potentially leading to more efficient muscle development.

Key Words: amino acids, exercise, sows

114 Sources of sulfur in beef cattle finishing diets and ruminal hydrogen sulfide concentration. J. O. Sarturi^{*}, G. E. Erickson, T. J. Klopfenstein, J. T. Vasconcelos, and K. M. Rplfe, *University of Nebraska, Lincoln.*

Effects of organic and inorganic sources of S on DM and S intake, VFA, ruminal pH and hydrogen sulfide concentration ($[H_2S]$) were evaluated in beef cattle finishing diets. Ruminally cannulated steers (n = 5; BW = 486 ± 39kg) were assigned randomly in a 5x5 Latin square design. Steers were fed once daily during 5, 21-d periods. Diets consisted of a corn control (CON), inorganic source (ammonium sulfate; INORG), organic source (corn gluten meal; ORG) fed at 9.8 or 23.3%, or wet distillers grains with solubles (WDGS; both sources of S) fed at 50%. Dietary S was 0.20, 0.37, 0.31, 0.46 and 0.50% for CON, INORG, low and high ORG, and WDGS, respectively. Intake and pH variables were evaluated during the last 7 d of each period. Ruminal gas samples were collected twice daily, at 8 and 13 h post feeding during the last 3 d of

each period, and [H₂S] evaluated colorimetrically. On d 21 of each period, ruminal fluid was collected at 8, 14 and 24 h post feeding for VFA. Statistical analyses were conducted using the GLIMMIX procedure of SAS, with day as a repeated measure for intake, pH and [H₂S], and time repeated for VFA. Intake tended ($P = 0.12$) to be 12% less for steers fed INORG compared with other treatments. Intakes of S were 35% less ($P < 0.01$) for ORG at low inclusion and INORG, compared with ORG at high inclusion and WDGS sources, whereas steers fed control diet had the least ($P < 0.01$) S intake (22 g/d). Area below ruminal pH 5.6 was 36 and 67% greater ($P < 0.01$) for INORG compared with ORG at high inclusion and other treatments, respectively. Steers fed INORG and WDGS diets had 49% greater [H₂S] than ORG at high inclusion, and 76% greater [H₂S] than CON and ORG at low inclusion ($P < 0.01$). Propionate was 16% greater ($P = 0.02$) and A:P ratio was 25% less for INORG than the other treatments. The inorganic source of S was able to induce greater [H₂S] even when S intake was not greater for this treatment, suggesting that rumen degradability of S is more important than total amount of S in the diet.

Key Words: hydrogen sulfide, inorganic, organic, sulfur sources

115 Irrespective of differences in weaning weight, feed efficiency is not different among pigs with varying average daily gain. C. K. Jones,* N. K. Gabler, R. G. Main, and J. F. Patience, *Iowa State University, Ames.*

Light weaning weight and poor post-weaning growth of pigs are both known to lower net profitability, but the resulting biological and physiological consequences are not well understood. This experiment evaluated the effects of pig weaning weight category (WW) on post-weaning average daily gain (ADG), feed intake, feed efficiency, body composition, and tissue deposition rates. A total of 120 PIC barrows were selected from a population of 960 weanling pigs to represent the 10% lightest, median, and heaviest pigs at weaning ($n = 30$ per WW category; BW = 4.6, 6.2, and 8.1 kg, respectively). Eight pigs per WW category were harvested on d 5 post-weaning as an initial slaughter group. The remaining 96 barrows were housed individually, fed ad libitum quantities of a commercial nursery phase feeding program for a 27-d growth and metabolism study, and were harvested on d 33 or 34 post-weaning. At the completion of the study, pigs in each WW category were divided into the slowest, median, or fastest 33% ADG category, yielding a nested design with 9 treatments plus an initial slaughter group. Although ADFI increased ($P < 0.0002$) with increasing WW and ADG categories, G:F was not different ($P = 30$). While tissue accretion rates varied ($P = 0.0002$) due to WW and ADG category, the composition of gain was not affected ($P = 0.12$ and 0.19 for protein and lipid deposition, respectively), even when expressed per metabolic body weight. In conclusion, both WW and ADG affect the physiological development of the pig.

Table 1.

Treatment	ADG, g/d	ADFI, g/d	G:F	% Protein	% Lipid	Protein Deposition, g/d/kg BW ^{0.60}	Lipid Deposition, g/d/kg BW ^{0.60}
Light WW							
–Slow ADG	378	421	0.92	15.3	10.9	8.9	4.9
–Median ADG	503	601	0.84	15.8	11.1	12.0	7.2
–Fast ADG	569	673	0.85	14.7	10.9	11.5	7.5
Median WW							
–Slow ADG	378	455	0.82	15.2	10.7	9.7	5.4
–Median ADG	579	699	0.83	15.8	11.9	12.4	8.4
–Fast ADG	672	845	0.79	15.8	12.1	13.7	9.6
Heavy WW							
–Slow ADG	543	655	0.85	15.2	11.8	10.6	6.7
–Median ADG	637	758	0.85	15.2	12.4	12.9	9.5
–Fast ADG	719	872	0.82	15.9	12.6	14.8	10.5
Pooled SEM	22.9	37.5	0.039	0.42	0.45	0.90	0.82

Key Words: carcass composition, deposition rate, pig

116 Reproductive performance of sows is affected by the dietary omega-6 to omega-3 fatty acid ratio. L. Eastwood*^{1,2}, P. Leterme³, and A. D. Beaulieu^{1,2}, ¹Prairie Swine Centre Inc, Saskatoon, SK, Canada, ²University of Saskatchewan, Animal and Poultry Science, Saskatoon, SK, Canada, ³Cargill R & D Centre Europe, Havenstraat, Vilvoorde, Belgium.

The objective of our experiment was to determine the effects of the omega-6 (n6) to n3 fatty acid (FA) ratio in sow diets on reproduction, piglet performance and plasma FA profiles. Sows ($n = 150$) were assigned to one of 5 test diets on d 80 of gestation and remained on these diets for 2 reproductive cycles. Diets (5% crude fat), divided into gestation and lactation rations, consisted of a control (tallow based) and 4 diets with n6:n3 ratios of 10:1, 5:1, 1:1 or 5:1 fish based. Blood was collected from 12 sows/diet during cycle 1 and another 12 sows/diet during cycle 2 for collection of colostrum and piglet blood to determine IgG and IgA content and FA profiles. During Cycle 2, fish diet sows consumed 10% less feed ($P = 0.04$), had reduced piglet birth weights ($P = 0.05$) and total litter weaning weights ($P < 0.01$). Average piglet weaning weights from these sows were reduced by 0.8 kg/piglet ($P = 0.04$). Stillbirths increased as the n6:n3 ratio decreased ($P = 0.03$). Colostrum and piglet serum IgA and IgG concentrations were unaffected by treatment ($P > 0.05$). Total plasma n3 FA's were highest in sows consuming 1:1 and fish based diets ($P < 0.0001$), with ALA being highest in the 1:1 sows and EPA and DHA being highest in the fish diet sows ($P < 0.0001$). Total plasma n3 FA's were highest in piglets of sows from the 1:1 and fished based diet groups ($P = 0.004$). In piglet plasma, ALA and DHA did not differ across treatment groups before suckling ($P < 0.05$); however, ALA was highest in post-suckle piglet plasma samples from the 1:1 diet group ($P < 0.005$), and EPA and DHA were highest in the post-suckle plasma of piglets from the fish based sows ($P < 0.0001$). Arachidonic acid (n6) was lowest in the 1:1 and fish groups in sow plasma ($P < 0.01$) as well as in piglet plasma ($P < 0.0001$). A dietary ratio of 5:1 (n6:n3) improved litter weaning weights, possibly through improvements in sow lactation feed intake.

Key Words: sow reproduction, Omega 3, PUFA

POSTER PRESENTATIONS

Graduate Student Poster Competition—M.S.

117 Low-fat wet distillers grains and beef quality. A. Haack*¹, C. Calkins¹, A. de Mello Jr.¹, S. Pokharel¹, L. Senaratne¹, J. Hergenreder¹, K. Varnold¹, T. Carr¹, G. Erickson¹, and D. Johnson², ¹University of Nebraska, Lincoln, ²University of Florida, Gainesville.

Strip loins (*M. longissimus lumborum*) from 45 USDA Choice steers were used to test the effects of diet oxidation, color changes during retail display, flavor and tenderness. The dietary treatments included a low-fat wet distillers grain without solubles (LFWDG; 4.72% fat) fed at 35% DM, traditional wet distillers grains with solubles (TWDGS; 6.91% fat) fed at 35% DM and a corn-based control diet. Four 2.5 cm steaks were cut for taste panels and Warner-Bratzler Shear Force (WBSF) testing. The remaining loin sections were cut into 1.3 cm thick steaks for measurement of oxidation with a thiobarbituric acid (TBA) assay and a 7 d retail display period. Four days after simulated retail display, samples from cattle fed LFWDG had more oxidation than TWDGS or control diets. Five days after simulated retail display, meat from LFWDG were less red in color (lower a*) and had more visual discoloration than other treatments ($P \leq 0.0001$ and $P \leq 0.05$, respectively). The L* and b* readings were not significantly different ($P \geq 0.05$). Samples from LFWDG were less tender ($P \leq 0.0006$) and had more off-flavor ($P \leq 0.02$) after display than TWDGS. Samples from LFWDG had approximately 10% more PUFA than TWDGS (4.86% vs. 4.46%, respectively; $P = 0.08$). These data suggest fatty acids contained within the distillers grains are partially protected from biohydrogenation during digestion, while fatty acids in the soluble fraction are more readily hydrogenated in the rumen. Consequently, diets formulated with LFWDG tend to compromise meat quality compared with TWDGS and corn-based control diet

Key Words: distillers grains, PUFA, oxidation, beef quality

118 Nutrient digestibility and performance of weaned pigs fed diets containing fermented soybean meal and phytase. L. A. Merri-man,* J. P. Holt, and K. W. Tudor, *Illinois State University, Normal.*

The inclusion of fermented soybean meal and addition of enzymes to weaned pig diets may reduce nutrient excretion and enhance performance. Two experiments were conducted to determine the effects of replacing conventional soybean meal with fermented soybean meal on growth performance and digestibility of weaned pigs. Barrows (n = 14, BW 9.35 kg) were placed into metabolism crates and randomly assigned to experimental diets containing either conventional soybean meal (CON) or 7% fermented soybean meal (FSBM) replacing conventional meal. Two phases of experimental diets were fed. Total urine and feces were collected during each phase for 3 d following a 7 d adjustment period. Gross energy of feed, feces, and urine was determined by bomb calorimetry and N using the combustion method. A growth assay was then conducted with 328 pigs (BW 6.28 kg) blocked by weight and sex. Pigs were placed into 44 nursery pens and fed one of 4 experimental diets consisting of: a standard corn/soy diet (CON), a diet containing 7% inclusion of fermented soybean meal (PSG), CON + phytase (PHY), or PSG + phytase (PP). Experimental diets were fed for 28 d in 3 phases. Pig weights and feed disappearance were measured weekly to determine ADG, ADFI, and G:F. DM, N, and energy digestibility was not different ($P > 0.05$) between pigs fed either CON

or FSBM during the metabolism trial. ADG of pigs consuming PHY (0.16 kg) and PP (0.15) was greater ($P < 0.05$) compared with those fed PSG (0.11) or CON (0.09) during phase 1 of the growth assay. ADFI of pigs fed PHY (0.44 kg/d) was greater ($P < 0.05$) compared with those fed PSG (0.37) during phase 2, with CON (0.39) and PP (0.42) fed pigs being intermediate. However, ADG was not different between treatments during this phase. No differences ($P > 0.05$) in ADG, ADFI, or G:F were observed during phase 3. Diets containing phytase increased ADG and ADFI during the early nursery phase. Fermented soybean meal can be used as a partial replacement of conventional soybean meal without impacting pig performance.

Key Words: phytase, swine, fermented soybean meal

119 Uterine expression of Na⁺/H⁺ antiporters 1, 2, and 4 in beef cows from 60 to 96 hours following CIDR removal. J. K. Grant* and G. A. Perry, *South Dakota State University, Brookings.*

When synchronized with a fixed-time AI protocol, cows that exhibited estrus had decreased uterine pH at insemination and greater pregnancy rates than cows that did not exhibit estrus. Research has reported expression Na⁺/H⁺ antiporter 1, 2, and 4 significantly decreased following onset of estrus among cows that exhibited estrus, but did not change among cows that did not exhibit estrus. Therefore, the objective of this study was to determine changes in uterine expression of Na⁺/H⁺ antiporter 1, 2, and 4 in cows from 60 to 96 h following CIDR removal. Angus-cross beef cows (n = 28) were synchronized with a PG-CIDR protocol. Cows received PGF_{2α} on d -9, GnRH and insertion of a CIDR on d -6, and PGF_{2α} and CIDR removal on d 0. At CIDR removal, transrectal ultrasonography was performed to determine dominant follicle size. Cows were blocked by follicle size, and uterine biopsies were collected at 60, 72, 84, or 96 h following CIDR removal. Total cellular RNA was extracted from all biopsies, and relative mRNA levels were determined by real-time RT-PCR and corrected for GAPDH expression. Onset of estrus was determined by the HeatWatch Estrous Detection System, and mean interval to estrus was 59.38 ± 4.82 h. There was no effect of time, estrus, or an estrus by time interaction on expression of Na⁺/H⁺ antiporter 1 ($P = 0.54, 0.84, \text{ and } 0.29$; respectively) or 4 ($P = 0.39, 0.09, \text{ and } 0.61$; respectively). Alternatively, there was an effect of time ($P < 0.01$), estrus ($P < 0.01$), and an estrus by time interaction ($P < 0.01$) on expression of antiporter 2. Among cows that exhibited estrus, expression of antiporter 2 was increased at h 72 compared with h 60, 84, or 96 ($P < 0.01$). Among cows that did not exhibit estrus, expression of antiporter 1, 2, and 4 did not change ($P > 0.10, P > 0.61, \text{ and } P > 0.21$; respectively). In summary, expression of Na⁺/H⁺ antiporter 1 and 4 did not change and antiporter 2 significantly increased 72 h following CIDR removal among cows that exhibited estrus, but did not change among cows that did not exhibit estrus.

Key Words: uterine pH, estrus, Na⁺/H⁺ antiporter

120 Effects of increasing PEP-NS on nursery pig performance. A. J. Myers*¹, M. D. Tokach¹, R. D. Goodband¹, S. S. Dritz¹, J. M.

DeRouchey¹, J. L. Nelssen¹, B. W. Ratliff², D. McKilligan², G. Xu³, and J. Moline³, ¹Kansas State University, Manhattan, ²Tech Mix Inc., Stewart, MN, ³Midwest Ag Enterprises, Marshall, MN.

A total of 180 nursery pigs (PIC 1050, initially 6.4 kg and 28 d of age) were used in a 24-d study to evaluate the effects of increasing PEP-NS on nursery pig performance. PEP-NS is a combination of porcine intestinal mucosa, dried fermentation biomass, and by-products of corn wet-milling. There were 5 pigs per pen and 6 pens per treatment. There were 6 dietary treatments: a negative control containing no specialty proteins, the negative control diet with 3, 6, 9, or 12% PEP-NS, or the negative control with 6% select menhaden fish meal (SMFM). The diet with 6% SMFM contained the same amount of soybean meal as the diet with 6% PEP-NS. A common pretest diet was fed in pellet form for the first 7 d post weaning. Experimental diets were fed in meal form from d 0 to 14, and a common diet was fed from d 14 to 24. From d 0 to 14, increasing PEP-NS increased (quadratic, $P < 0.01$) ADG, ADFI, and G:F with the greatest response observed in pigs fed 9% PEP-NS. There were no differences ($P > 0.29$) between pigs fed 6% PEP-NS or 6% SMFM. When pigs were fed a common diet from d 14 to 24, there were no differences in performance among treatments. Overall (d 0 to 24), pigs fed increasing PEP-NS had improved (quadratic; $P < 0.01$) ADG and G:F, with the greatest improvement seen as PEP-NS increased from 3 to 6%. These results suggest that feeding 6% to 9% PEP-NS in phase 2 nursery pig diets is suitable replacement for 6% SMFM.

Table 1. Effects of PEP-NS on nursery pig performance

Item	PEP-NS, %					P-value			
	0	3	6	9	12	6% SMFM	SEM	Linear	Quadratic
d 0 to 14									
ADG, g	197	289	353	373	328	351	12	<0.01	<0.01
ADFI, g	359	401	437	455	410	450	13	0.01	0.01
G:F	0.550	0.721	0.808	0.819	0.797	0.781	0.018	<0.01	<0.01
d 0 to 24									
ADG, g	367	397	447	440	417	449	13	<0.01	<0.01
ADFI, g	559	560	599	598	569	617	16	0.27	0.10
G:F	0.658	0.707	0.746	0.737	0.733	0.729	0.015	<0.01	<0.01

Key Words: fish meal, PEP-NS, nursery pigs

121 The effects of supplementing beef cows grazing cornstalk residue with a dried distillers grain based cube on cow and calf performance. J. M. Warner,* J. L. Martin, Z. C. Hall, L. M. Kovarik, K. J. Hanford, and R. J. Rasby, *University of Nebraska, Lincoln.*

Multiparous, spring calving, crossbred (Simmental x Angus) beef females (n = 832) were used over 5-years to study the effects of supplementing a dried distillers grain cube to cows grazing cornstalk residue on cow and calf performance. Cows were blocked annually by age, body condition score (BCS), body weight (BW), and calving date and assigned randomly to one of 2 treatments. Treatments were 1) supplemented (SUPP) with protein using a dried distillers grains with solubles (DDGS) cube or 2) not supplemented (CON) during the last trimester of pregnancy. SUPP and CON cows were managed together from the onset of calving until the start of cornstalk grazing. Each year by treatment group was considered an experimental unit. Cow weight (574.5 ± 10.7 kg) was similar at initiation of cornstalk grazing, at the end of cornstalk grazing (608.5 ± 7.5 kg), and at the initiation of the

breeding season (566 ± 4.4 kg) for both groups. Supplementation did not affect BCS at the start of the breeding season (5.4 ± 0.1) or BCS at the initiation of cornstalk grazing the subsequent year (5.4 ± 0.1). BCS of SUPP cows was greater ($P = 0.02$) at the end of cornstalk grazing than CON cows (5.6 vs. 5.4 ± 0.1). Calving interval, calf birth weight, and actual calf weaning weights were not different between groups. Percentage of cows cyclic before the breeding season and final pregnancy rates were similar. Heifer progeny (n = 306) were not different in initial weight (277.5 ± 10.2 kg), final weight (351 ± 11.5 kg), initial BCS, final BCS, or ADG (0.45 ± 0.04 kg/d) for both treatment groups. Heifer age at puberty, estrus response to synchronization, A.I. conception rate, A.I. pregnancy rate, and final pregnancy rate were similar. Supplementation of a DDGS cube to cows grazing cornstalk residue improves BCS in the last trimester without affecting calf performance or reproduction. Dam supplementation regimen did not alter growth or reproductive performance of heifer progeny.

Key Words: cornstalk residue, beef cows, beef heifers, supplemental protein

122 Growth performance, nutrient digestibility, and whole body oxygen consumption in growing pigs fed DDGS-containing diets supplemented with a multicarbohydase enzyme. A. K. Agyekum,* T. A. Woyengo, B. A. Slominski, and C. M. Nyachoti, *University of Manitoba, Winnipeg, MB, Canada.*

The aim was to determine growth responses and apparent total tract nutrient digestibility in growing pigs fed diets containing graded levels of DDGS and to determine the effect of a multicarbohydase enzyme (MC) supplementation on visceral organ mass and whole body oxygen consumption (WBOC). In Exp. 1, 48 pigs (~26 kg BW) were assigned to 4 diets (6 pens/diet; 2 pigs/pen) based on corn-barley-SBM with 0, 10, 20 and 30% DDGS in a 42-d trial. Apparent total tract digestibilities (ATTD) of DM, energy, and N were determined using AIA as the indigestible marker. Inclusion of DDGS tended ($P = 0.072$) to decrease ADG (0.85, 0.88, 0.78, 0.75 kg/d) but not ($P > 0.10$) ADFI (1.81, 1.80, 1.80, 1.71 kg/d) and G:F (0.47, 0.46, 0.44, 0.43). Diet had an effect on ATTD of energy and nutrients ($P < 0.05$). In Expt. 2, 24 pigs (~20 kg BW) were randomly assigned to 3 corn-SBM-based diets (8 pigs/diet): control (C, 0% DDGS), C + 30% DDGS or C+30% DDGS + MC. On d 15, WBOC during the 24- to 30-h postprandial period was determined using an open-circuit indirect calorimeter on 4 pigs/diet. On d 28, pigs were killed to determine visceral organ mass. There was no diet effect ($P > 0.10$) on final BW, WBOC, and liver, spleen, pancreas, stomach, cecum and small intestine weights relative to empty BW. However, pigs fed the C and C+30% DDGS+MC had heavier ($P = 0.053$) empty BW compared with those fed unsupplemented diets. Colon plus rectum and the portal-drained viscera (PDV) were heavier ($P < 0.05$) in DDGS-fed pigs compared with the Control. Results show that including DDGS in grower pig diets up to 30% has no effect of performance although ATTD of energy, DM, and N may be reduced. Inclusion of DDGS at 30% increased PDV mass and reduced dressing percentage but these effects were overcome by MC supplementation.

Key Words: performance, DDGS, portal-drained viscera, pigs

123 Effect of ewe body condition during mid to late gestation on progeny mammary epithelial cell proliferation. K. E. Boesche,* A. L. Hunter, K. M. O'Diam, S. C. Loerch, and K. M. Daniels, *The Ohio State University, Ohio Agricultural Research and Development Center, Wooster.*

Dam body condition score (BCS) during mid to late gestation may affect progeny mammary epithelial cell proliferation. To study this possibility, pregnant ewes (≈ 80 d of gestation) were allotted to pens ($n = 18$; 5 ewes per pen) based on initial BCS of 2.0, 3.0, or 4.0 (on a 1 to 5 scoring system with 1 being extremely thin and 5 being extremely fat). A maintenance diet consisting of limit-fed corn silage was fed to animals assigned to BCS 2.0 (2.6 Mcal ME/d). Ewes with a BCS of 3.0 and 4.0 were fed the maintenance diet plus additional corn to provide 3.0 Mcal ME/d and 3.4 Mcal ME/d, respectively. Diets were adjusted every 2 wk to maintain BCS throughout pregnancy. Post-lambing nutrition and management were the same across treatment. Weaned lambs (≈ 56 d of age) entered a feedlot phase and were finished on a completely pelleted 70% concentrate diet. Female progeny were slaughtered at an average BW of 52 kg and udders were removed. Mid-parenchymal samples were obtained, fixed in formalin, and later embedded in paraffin blocks. Five- μm thick tissue sections were cut, mounted onto slides, and underwent immunohistochemical staining for the Ki67 antigen, a cell proliferation marker. A Ki67 labeling index (number of Ki67 positive epithelial cells / number of total epithelial cells $\times 100$) was determined for each lamb. Data were analyzed with the Mixed Procedure of SAS using a model that included the effect of dam BCS and considered the covariates breed, parity, birth type, and rear type. Dam BCS tended to affect ($P = 0.099$) Ki67 labeling index of progeny. Lambs born to dams with BCS of 4.0 had the lowest Ki67 labeling index ($4.15 \pm 0.72\%$), followed by lambs born to dams with BCS of 3.0 ($6.03 \pm 0.78\%$). Lambs born to dams with BCS of 2.0 had the highest observed Ki67 index ($6.31 \pm 0.83\%$). These data suggest but do not demonstrate an effect of dam BCS during mid to late gestation on postnatal progeny mammary epithelial cell proliferation. Mammary epithelial cell number is positively correlated with milk yield. Our observations here require further evaluation as they may have important lactation performance implications.

Key Words: sheep, body condition, mammary

124 The effect of exercise on lactating sow performance. E. E. Higgins^{*1}, E. M. Baxter², D. E. Gerrard¹, and C. M. Wood¹, ¹Virginia

Polytechnic Institute and State University, Blacksburg, ²Scottish Agricultural College, Edinburgh, Scotland.

Improving reproductive performance by exercising sows during lactation has not been extensively researched. The objective of this study was to determine the effect of daily light exercise on body condition score (BCS), lameness score (LS), wt loss (WL), backfat depth (BF) and piglet growth of lactating sows housed in farrowing crates. A total of 24 sows were used in 4 trials. Sows were moved into farrowing crates at d 109 of gestation. Body wt, BF, BCS, and LS were recorded at that time and again at weaning. All scores were on a 1–5 scale, 1 being emaciated (BCS) or unable to walk (LS) and 5 being obese (BCS) or sound (LS). Within each trial, before farrowing, 6 sows were grouped by BW and parity then randomly assigned to control (no exercise; CON) or treatment (exercise; TRT) groups. For 17–19 d after all sows farrowed, TRT sows ($n = 3$) were removed from their crates daily and encouraged to exercise for 1 h while CON sows ($n = 3$) remained in crates 24 h/d. Exercised sows were video recorded during the exercise period and locomotion of all sows was recorded at weaning. Saliva samples were collected from all sows 30 min before exercise and at 30 and 60 min after exercise for cortisol analysis. Sows were fed a lactation diet to appetite twice daily. Piglets were weaned between 18 and 26 d of age. Piglet birth and weaning wt were recorded, along with any deaths, injuries or illnesses. Data were analyzed using a model that included effects of trial and treatment. Piglet ADG was 0.25kg (TRT) and 0.21kg (CON). Mean WL was 27.5kg (TRT) and 18.2kg (CON). The difference in BF loss was significant ($P < 0.05$); TRT sows lost 5.3 mm, CON sows lost 18mm. Average BCS of TRT sows changed from 2.8 pre-farrowing to 2.4 at weaning; average BCS of CON sows changed from 3.0 to 2.5. Change in LS over that time was significant ($P < 0.05$), 0.18 (TRT) and -0.43 (CON). These results indicated that exercised sows were less lame and leaner than control sows, without affecting piglet growth.

Key Words: behavior, exercise, lactation, swine

Graduate Student Poster Competition—Ph.D.

125 An assessment of four components of sow lifetime nonproductive days on high-, intermediate- and low-performance commercial breeding farms. Y. Sasaki* and Y. Koketsu, *Meiji University, Kawasaki, Kanagawa, Japan.*

The objectives of the present study were to measure the 4 lifetime components of sow nonproductive days (NPD) and proportions of the 4 lifetime NPD components by farm productivity groups, categorized by pigs weaned per mated female per year, averaged over 5 years. Lifetime records of 44,720 sows were extracted from records of 101 Japanese commercial farms. The NPD of sows was defined as the number of days when sows were neither gestating nor lactating. Lifetime NPD were divided into 4 components: first-mating-to-conception interval at parity 0 (FMCI), lifetime weaning-to-first-mating interval (WMI), lifetime sow first-mating-to-conception interval (MCI), and last weaning-to-culling interval (WCI). Three farm productivity groups were formed on the basis of the upper and lower 25th percentiles of pigs weaned per mated female, averaged over 5 years: high-, intermediate-, or low-performing farms. Mixed effect models were used to compare

performance measurements between the 3 farm groups. Mean values of lifetime NPD and parity at culling (\pm SEM) were 87.4 ± 0.31 d and 4.5 ± 0.01 , respectively. Mean values of FMCI, lifetime WMI, lifetime MCI and WCI were 5.8 ± 0.10 , 27.4 ± 0.11 , 14.9 ± 0.16 , and 39.3 ± 0.23 d, respectively, and comprising 6.6, 31.4, 17.0, and 45.0%, respectively of lifetime NPD. High-performing farms had lower lifetime NPD and 4 NPD components than low-performing farms ($P < 0.05$), although there were no differences between the farm groups in herd life days and female life days. In all farm groups, sows culled at parity 4 or 5 had the highest lifetime NPD ($P < 0.05$). On high-performing farms, the relative contributions of the NPD components in FMCI, lifetime MCI, and WCI were 1.9 to 5.4% lower than those on low-performing farms ($P < 0.05$). In conclusion, to improve sow lifetime efficiency it is important to decrease the duration of each NPD component. Additionally, the relative contribution of WCI is the largest of the 4 NPD components, so controlling this is especially critical.

Key Words: lifetime efficiency, management, removal, swine

126 Effects of plant extracts on cytokine production of porcine alveolar macrophages. Y. Liu*¹, T. M. Che¹, D. Bravo², and J. E. Pettigrew¹, ¹University of Illinois, Urbana, ²Pancosma SA, Geneva, Switzerland.

Plant extracts (PE) are bioactive substances of some foods or traditional herbs, known to possess antioxidant, antibacterial, and perhaps immunoregulatory effects. This study investigated the in vitro anti-inflammatory effects of several PE (carvacrol, capsicum oleoresin, cinnamaldehyde, garlic, eugenol, anethol, and turmeric oleoresin) on porcine alveolar macrophages (PAM) isolated from 6 weaned pigs by bronchoalveolar lavage. The experimental design for this assay was a 2 (with or without 1 µg/mL LPS) × 5 (levels of PE) factorial arrangement. The application levels of PE were 0, 25, 50, 100, and 200 µg/mL, except for cinnamaldehyde and turmeric oleoresin, which were 0, 2.5, 5, 10, and 20 µg/mL. The 3-(4,5-Dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay was used to determine the cell viability of PAM and enzyme-linked immunosorbent assay (ELISA) was applied to measure TNF-α, IL-1β, TGF-β, and IL-10 in the cell culture supernatants of PAM. Data were analyzed by ANOVA as randomized complete block design with pig as a random block, due to pig as the source of PAM. The results showed high levels (200 µg/mL) of carvacrol and garlic were cytotoxic to PAM, and even low levels of turmeric oleoresin (20 µg/mL) significantly reduced cell viability ($P < 0.05$). LPS reduced ($P < 0.05$) cell viability and increased ($P < 0.001$) TNF-α and IL-1β, but did not affect TGF-β. In the LPS group, all PE suppressed ($P < 0.05$) the release of TNF-α by 15% to 100%. Carvacrol, cinnamaldehyde, garlic, and eugenol reduced ($P < 0.05$) the production of IL-1β by 31% to 95%, but capsicum oleoresin and anethol did not. Carvacrol, garlic, eugenol, and turmeric oleoresin reduced ($P < 0.05$) TGF-β by 5% to 9%. Without LPS stimulation, capsicum oleoresin, cinnamaldehyde, anethol, and turmeric oleoresin increased ($P < 0.05$) TNF-α, and all PE except eugenol increased ($P < 0.05$) IL-1β secretion. Garlic, eugenol, and turmeric oleoresin reduced ($P < 0.05$) TGF-β. The anti-inflammatory cytokine IL-10 was not detected in any supernatant. In conclusion, the results suggest that all of these PE may have various levels of potent anti-inflammatory effects.

Key Words: alveolar macrophage, plant extracts, weaned pigs

127 Circulating concentrations of progesterone in ovariectomized beef heifers receiving a new, once-used, or twice-used CIDR for 5 days. P. J. Gunn*¹ and G. A. Bridges², ¹Purdue University, West Lafayette, IN, ²University of Minnesota, Grand Rapids.

The objective of this experiment was to compare circulating concentrations of progesterone (P4) in ovariectomized beef heifers treated with either a new, once-used, or twice-used intravaginal progesterone insert (CIDR®, Pfizer Animal Health) containing 1.32 g of P4 for 5 d. Heifers (n = 30), ovariectomized 21 d before study initiation, were commingled and maintained on 8.2 kg DM•hd⁻¹•d⁻¹ of a feedlot pre-conditioning diet. Heifers were stratified and blocked by BW (360 ± 20 kg) within BCS (4.9 ± 0.44) and randomly allotted within block to 1 of 3 treatments (n = 10/treatment). Treatments were: 1) new CIDR (NEW); 2) once-used CIDR previously used in a 5-d estrous synchronization protocol (1X); and 3) twice-used CIDR previously used in 2 5-d estrous synchronization protocols (2X). Used CIDRs were disinfected, air-dried at room temperature and stored at -20°C between uses. Previous CIDR uses occurred within 60 d before initiation of the trial. CIDRs were inserted on d 0 and removed on d 5. Blood samples were collected immediately before CIDR insertion on d 0 and preprandial daily between d 1 and 7. Concentrations of P4 were analyzed using

the MIXED procedures of SAS, using REPEATED measures when appropriate. A treatment × day interaction was noted ($P = 0.002$) for P4 concentrations. Concentrations of P4 did not differ ($P > 0.05$) between treatments before CIDR insertion (d 0) and on d 6 and 7. However, concentrations of P4 were greater ($P < 0.05$) in NEW treatment than the 1X and 2X treatments on d 1 and 2, while concentrations of P4 in the NEW and 1X treatments were greater than the 2X treatment on d 3 through 5. As number of CIDR uses increased, average concentrations of P4 during CIDR insertion decreased ($P < 0.001$). Peak P4 concentrations and area under the curve during CIDR insertion was greater in NEW ($P < 0.001$) than 1X and 2X treatments. Although reduced with a twice-used CIDR, circulating concentrations of P4 never declined below 1.0 ng/mL suggesting that such treatment would be sufficient in preventing estrus expression and ovulation in heifers.

Key Words: 5 d CIDR, heifer, ovariectomized, progesterone

128 Efficacy of yeast based feed additives to reduce the effects of chronic exposure to deoxynivalenol and zearalenone on internal organ health of pigs. A. C. Chaytor*¹, M. T. See¹, J. A. Hansen^{2,1}, D. C. Kendall², T. F. Middleton³, P. R. O'Quinn⁴, and S. W. Kim¹, ¹North Carolina State University, Raleigh, ²Murphy-Brown, LLC, Rose Hill, NC, ³Ag ProVision, LLC, Kenansville, NC, ⁴Prestage Farms, Inc, Clinton, NC.

Two feed additives with potential ability to detoxify mycotoxins were tested to determine the effects on internal organ health of pigs fed diets containing deoxynivalenol (DON) and zearalenone (ZEA) for 42 d. Gilts (n = 84, 9.1 ± 0.4 kg BW) were allotted to 4 treatments (7 replicates with 3 pigs per pen): PC (positive control with 0.3 mg DON/kg and undetectable ZEA); NC (negative control with 4.8 mg DON/kg and 0.3 mg ZEA/kg); A (NC + yeast cell wall product, 2 g/kg); C (NC + yeast fermentation product, 2 g/kg). On d 42, pigs were killed to obtain samples of liver, kidney, spleen, uterus, and jejunum. Pigs in NC had a 25% reduction ($P < 0.05$) in ADG (288 g) and a 31% reduction ($P < 0.05$) in ADFI (564 g) compared with pigs in PC (433 and 910 g, respectively). Pigs in A and C had greater ($P < 0.05$) ADG (332 and 345 g, respectively) and ADFI (640 and 662 g, respectively) than pigs in NC. No difference was seen between treatments for the liver, kidney, or spleen weights as a % of BW, but pigs in NC tended ($P = 0.063$) to have a greater uterus weight as a % of BW than pigs in PC (0.06 vs. 0.04%). There was no difference among treatments for villi and crypt lengths in jejunum, and the width of uterus endometrium. However, pigs in NC had a greater ($P < 0.05$) uterine circular muscle width than pigs in A, but did not differ from pigs in PC or C. Pigs in NC had greater ($P < 0.05$) liver hydropic degeneration than pigs in PC and C, and tended ($P = 0.079$) to be greater than pigs in A. There were no differences among treatments for all other measurements of liver and kidney damage. Collectively, feeding diets with 4.8 mg DON/kg and 0.3 mg ZEA/kg to pigs for a 42 d period reduced growth performance and caused partial tissue damage of the liver. These 2 feed additives improved ADG and ADFI, and partly reduced tissue damage.

Key Words: deoxynivalenol, organ damage, pigs, zearalenone

129 Creep feed: effects of feed flavor supplementation on pre- and post-weaning performance and behavior of piglet and sow. T. X. Zhou,* I. H. Kim, L. Yan, B. U. Yang, and H. D. Jang, Dankook University, Department of Animal Resource & Science, Rheonan, Choongnam, South Korea.

This study was conducted to evaluate the effects of flavor supplementation on pre- and post-weaning performance and behavior of piglets and sows. A total of 30 sows (Landrace × Yorkshire) and their litters were employed in this study. Sows were randomly assigned to 3 dietary treatments (10 replications per treatment). Dietary treatments included: 1) CON, basal diet; 2) TRT1, CON + 0.1% vanilla flavor supplement; 3) TRT2, CON + 0.1% cheese flavor supplement. The behavior of sows (nursery, eating and standing) and piglets (eating, sleeping and fighting) in each treatment was monitored throughout experiment. Each piglet was weighted at 5, 10, 15 and 21 d after birth to evaluate the average daily gain. Sows and piglets were bled on the weaning day to evaluate the blood characteristics. Backfat and estrus interval were investigated. In this study, there were no differences ($P > 0.05$) in diarrhea score and blood characteristics among treatments. Likewise, the behavior was not influenced ($P > 0.05$) by the dietary flavor supplementation. However, administration of flavor increased ($P < 0.05$) the post-weaning ADG and G/F ratio in the current study, whereas the benefit of flavor addition was not seen ($P > 0.05$) pre-weaning. No significant difference was observed ($P > 0.05$) on the blood characteristics, behavior, backfat loss and estrus interval among treatments. In conclusion, administration of flavor could increase piglet ADG post-weaning, whereas inclusion of flavor had no influence on blood characteristics and performance in sow and piglets.

Key Words: behavior, creep feed, flavor, piglet

130 Influence of herb for increasing milk yield on performance in sows. H. J. Kim,* I. H. Kim, S. M. Hong, X. Ao, and S. Zhang, *Dankook University, Department of Animal Resource & Science, Cheonan, Choongnam, South Korea.*

This study was conducted to evaluate the effects of dietary traditional medicinal herb powder for increasing milk yield supplementation on performance in sows. The present experiment was conducted in a commercial farm. A total of 30 sows (Landrace × Yorkshire, parity = 3) were allotted to 1 of the 3 treatments with 10 replicate pens per treatment and 1 sow per pen. Dietary treatments included: 1) CON, basal diet; 2) H1, basal diet + 0.01% (*scutellaria baicalensis* + *astragalus membranaceus*); and 3) H2, basal diet + 0.01% (*codonopsis pilosula* + *angelica gigas nakai*). All sows were received experimental diets 1 week before the parturition day until the weaning day. Initial and final backfat was not affected ($P > 0.05$) by dietary herb supplementation, however, pigs fed the dietary herb had a higher ($P < 0.05$) backfat loss compared with CON treatment. No difference was observed on oestrus interval ($P > 0.05$). There was no difference on average body weight on the day of birth, 14 and weaning among all treatments ($P > 0.05$). However, body weight on d 14 d and weaning day was higher ($P < 0.05$) in H2 treatment than that in CON and H1 treatments. Diarrhea score was recorded from d 0 to d 7, and 2 litters in CON treatment had severe diarrhea thus a value of 3.5 diarrhea litters per day was observed in CON treatment. Piglets in H1 and H2 treatments showed mild diarrhea. Litter size, weaning number and mortality rate were not affected by dietary treatments. During the experimental period, the average litter size and weaning number of the farm was 11.25 and 9.5, respectively. In conclusion, backfat loss was increased by dietary herb supplementation, and piglets in H2 treatment had a higher weaning weight compared with that in CON treatment.

Key Words: herb, milk yield, performance, sows

131 Oxidation of U-13C- α -linolenic acid is low and independent of body weight and previous nutrition in pigs fed flaxseed containing diets. H. R. Martínez-Ramírez* and C. F. M. de Lange, *University of Guelph, Guelph, ON, Canada.*

It was hypothesized that in growing pigs the oxidation rate of α -linolenic acid (ALA) is determined by the cumulative intake of ALA, not by BW, and thus reflects both previous and current dietary ALA intake levels. A total of 12 purebred Yorkshire gilts (14.6 ± 0.41 kg initial BW; 4 pigs per treatment) were housed individually and fed corn-wheat-soy based diets containing varying levels of flaxseed (FS) in 2 phase feeding programs: T1, 10% FS diet between 15 and 37 kg BW; thereafter 5% FS diet up to 50 kg BW; T2, 0% FS diet (CON) between 15 and 37 kg BW; thereafter 5% FS diet up to 50 kg BW; and T3, 10% FS diet between 15 and 37 kg BW; thereafter CON up to 50 kg BW. Feed intake was fixed at 95% of the voluntary feed intake according to NRC (1998). At each of the 2 BW (25 and 50 kg), 2.75 mg/kg BW of uniform labeled-13C-ALA was fed to pigs in a single bolus dose. Oxidation rates were expressed as a proportion of the administered tracer dose recovered as $^{13}\text{CO}_2$ from breath during 26 h after feeding the tracer. For pigs fed FS during a particular phase, cumulative FS intake between 15 and 25 kg BW or between 37 and 50 kg BW was similar among treatments (1.54 kg/pig; $P = 0.891$). There was no effect of previous FS intake on the oxidation rate of ALA at 50 kg BW (8.0% for T1 vs. 5.7% for T2; $P = 0.478$). Similarly, BW did not affect the oxidation rate of ALA for pigs fed FS (9.1% at 25 kg BW vs. 5.67% at 50 kg BW; $P = 0.333$). When comparing the feeding programs across BW, T1 tended to have higher mean oxidation rate of ALA than T2 (9.81 vs. 5.07%, $P = 0.059$), whereas mean oxidation rates were similar for T2 and T3 (5.07 vs. 5.73%; $P = 0.938$). Across BW and treatments pigs fed FS tended to have higher oxidation rate of ALA than pigs fed CON (7.97 vs. 4.67%; $P = 0.081$). These results indicate that the ALA oxidation rate was less than 10% of intake, not affected by BW and previous nutrition, and reduced in diets with low ALA content.

Key Words: pig, flaxseed, α -linolenic acid, β -oxidation

132 Characterization of nucleotide and predicted amino acid sequence of a porcine Interleukin-1 beta (IL1B) variant expressed in elongated porcine embryos. D. J. Mathew*¹, E. M. Newsom¹, R. D. Geisert¹, J. A. Green¹, C. K. Tuggle², and M. C. Lucy¹, ¹University of Missouri, Columbia, ²Iowa State University, Ames.

Pigs suffer from a high rate of embryonic mortality. Most losses occur during conceptus attachment. Near d 12 of pregnancy, pig conceptuses increase expression of IL1B. Based on pig genome sequences and expressed sequence tags (EST), there appeared to be at least 2 IL1B genes - the prototypical IL1B cytokine (secreted by macrophages and other immune cells) and an embryonic IL1B (IL1BE) expressed by the pig conceptus during attachment. The objective was to clone a full-length cDNA for IL1B and IL1BE and compare the 2 forms at the nucleic acid and predicted amino acid level. Primers were designed based on EST in GenBank and used to amplify cDNA from porcine peripheral blood leukocytes (PBL) and porcine elongated embryos. Forward primer sequences were 5'-CAGCCAGTCTTCATGTTCAG-GTT-3' for IL1B and 5'-AGGACGGCATTCTGAAGGAA-3' IL1BE. A common reverse primer was used 5'-ATCTAGGGAAGACAGCT-GGGCAT-3'. Four cDNA clones for embryo and 3 cDNA clones for PBL were sequenced. The IL1B and IL1BE cDNA were 984 and 977 bp and 93% identical at the nucleic acid level. The translated proteins were 267 amino acids in length. Across the entire length, the amino acids were 85% identical. Homology was less ($P < 0.01$) within the

“prepro” region (78% identity) compared with the mature region of the peptide (92% identity). Homology was 100% from amino acid 204 to the end (amino acid 267). Alignment of the IL1BE with the porcine genome sequence (NCBI) indicated the existence of an alternative exon 1 (exon 1E) approximately 10 kb upstream from exon 2. Using ribonuclease protection assays, the IL1BE mRNA was detected in fila-

mentous embryos but not PBL. The existence of a second embryonic IL1B may be unique to the pig and may play a role in physiological events surrounding the establishment of pregnancy. This project was supported by National Research Initiative Competitive Grant no. 2007-35203-17836 from the USDA NIFA.

Key Words: porcine, conceptus, interleukin 1 Beta, uterus

Tuesday, March 15, 2011

SYMPOSIA AND ORAL SESSIONS

Graduate Student Symposium: Tips on How to Navigate the Job Search and Interview Process for Animal Science Students

133 Tips on how to navigate the job search and interview process for animal science students. D. Simmons,* *Continental Search & Outplacement, Inc.*

Getting your career on the right track requires finding the right job for your skills and ambitions. In this fast-paced session, we will go through **10 Steps to Find and Get the Job You Desire and Deserve**. These steps include creating a *Plan A* for your career along with why it is important to create *Plan B*. You will learn how to reach out to recruiters to attract their attention and determine the best job boards to use along with maximizing their tools. Today, most job searches are happening virally and you will learn specific networking techniques that will connect you most effectively, both in-person and online, teaching you how to utilize search engines and social media platforms to your benefit. Various social media sites will be discussed along with tips on what your resume should say and social media etiquette regarding content that should and should not be on Facebook, Twitter, and blog. A special webpage has been designed for attendees with tips and access to Web sites discussed.

Key Words: job search, employment, resume, recruiter

134 You got the interview, now what? Part 1: Tips on interviewing for a graduate assistantship successfully. G. P. Lardy,* *North Dakota State University, Fargo.*

Going to graduate school is different than being an undergraduate. In some cases, applying to and getting accepted into graduate school involves an interview with the major professor and other departmental personnel. Preparing for an interview can be a bit intimidating. Don't let the apprehension or fear of the interview process paralyze you into failing to prepare adequately for it. Here are some simple tips for preparing for the interview. 1) Find out the details regarding the interview as soon as you can. What is the schedule? Who will you meet with? If possible, meet with multiple faculty members during the interview. Request time to meet with current students enrolled in the program. 2) Read recent scientific publications from the faculty member and the department. This gives a good perspective of recent work. 3) Ask good questions. Write them down ahead of time. Here are some questions which should be answered by the time you are done with the interview. Where does this faculty member place most of their students? Are those careers interesting to me? What types of projects will I be working on? Will I enjoy working with my major professor? 4) Be on time. Plan your travel so you can arrive well in advance of the start of the interview. 5) Be genuinely interested in the position. Don't go on an interview for recreational purposes. It wastes your time and the time and resources of your host and their department. 6) During the

exit interview, be sure to ask for clarification of any items you did not understand. This is the time to discuss the availability of assistantships if you have not done so already. Do assistantships cover the cost of tuition? 7) Don't be afraid to follow up with the faculty member if you need to clarify something after the interview. Keep in mind the interview serves multiple purposes, 1) to get a feel for the faculty member as a boss, 2) to determine if the department and university are a good place to further your education, and 3) to determine employment opportunities following graduation. It also functions as a means for the faculty member to see if you are a good fit for their research program. I wish you the best of luck in the interview process.

Key Words: career, interview, graduate school, assistantship

135 You got the interview, now what? - Part 2: How to interview for an industry position successfully. G. Weilbaker,* *Career Solutions, Fort Wayne, IN.*

The Interview Stage 1. Remain flexible and make yourself available. Confirm your interview time and Itinerary. Find out address and directions. Find out the appropriate dress attire. Groom well, no piercings or tattoos. Do background research on the company and interviewers. Research other people in a similar type position. Write down specific questions for each interviewer. Review resume and references; bring extra copies.

Interview Stage 2. Arrive 30 min early and survey the area and facility. Silence electronic devices. Acknowledge everyone within contact range. Firm handshake, good eye contact and speak clearly. Avoid slang terms such as: dude, like, tight. Listen to interviewer, understand what they are asking. Ask some open ended and specific questions. Give specific examples of things you have done. Develop an in depth portfolio of your experience to supplement resume. Ask for the job. Clarify the next step and time table in the hiring process. Obtain business cards with contact info for everyone you talked to during the interview process.

Interview Stage 3. Follow up letter; email immediately. 1st Paragraph: Thanks, not general, be specific. 2nd Paragraph: What you liked and feel the company offers. 3rd Paragraph: What you offer, experience, education, desire, etc.. 4th Paragraph: Ask for action, next step.

Interview Stage 4. The Offer. Get it in writing. Ask good questions to clarify details. Do not obsess about minor details. Offers can and often are withdrawn. How to handle multiple offers. Share the facts on other offers. Negotiate one time. Always leave the door open on offers you reject.

Key Words: interview stages

Growth, Development, Muscle Biology, and Meat Science: Role of Adipose Tissue in Skeletal Muscle

136 (Invited) Dietary fat and meat quality. J. K. Apple,* *University of Arkansas, Department of Animal Science, Fayetteville.*

Fats and oils have been used for decades to increase the caloric density of livestock diets; thereby reducing feed intake and resulting in improved feed efficiency. In addition, the inclusion of fats/oils in livestock diets typically produces fatter carcasses with greater dressing percentages and reduced lean meat yields. Yet, the effects of dietary fats/oils on quality, especially meat color and water-holding capacity, are quite variable. There is contradictory evidence that elevating the fat/oil content of finishing diets alters marbling scores/intramuscular fat content (IMF); yet, several studies have demonstrated that feeding conjugated linoleic acid (CLA) can elevate LM marbling scores and/or IMF between 12 and 44%. The greatest impact of dietary fats/oils is on altering the fatty acid composition of edible fats, which, in turn, impacts fat quality and meat palatability. Because the fatty acid composition of pork is a reflection of the fatty acid composition of the diet, it is not surprising that feeding diets high in PUFA will cause the PUFA composition, as well as the iodine value (IV), of pork fat to increase, resulting in softer fat and bellies. Moreover, feeding seed oils, or other dietary PUFA sources, can lead to greater lipid oxidation during storage and development of undesirable, off-flavors in cooked pork. On the other hand, rumen microflora hydrogenate the PUFA in the diets of cattle into SFA and MUFA, and, until recently, it was almost impossible to manipulate the fatty acid composition of beef. However, encapsulation/protection of dietary PUFA has been shown to increase the proportion of PUFA in beef. Additionally, the feeding of fish oils, containing high amounts of the long-chain *n*-3 PUFA, has been shown to elevate beef *n*-3 PUFA composition, indicating that these dietary PUFA were either only partially-hydrogenated or completely bypassed rumen-hydrogenation. Yet, these studies have also demonstrated that beef from cattle fed diets containing fish oils has a shorter shelf-life, and imparts abnormal odors and oxidized off-flavors, thereby reducing the overall acceptability of cooked beef products.

Key Words: dietary fat, fatty acid composition, meat quality

137 (Invited) Use of genomics to improve the fatty acid composition of meat. J. M. Reecy*¹, R. G. Tait¹, D. L. VanOverbeke², A. J. Garmyn², R. G. Mateescu², A. L. Van Eenennaam³, Q. Duan¹, Q. Liu¹, J. P. Schoonmaker¹, M. E. Drewnoski¹, D. C. Beitz¹, K. Kizilkaya^{1,4}, R. L. Fernando¹, and D. J. Garrick¹, ¹*Iowa State University, Ames*, ²*Oklahoma State University, Stillwater*, ³*University of California, Davis*, ⁴*Adnan Menderes University, Turkey*.

Beef is a nutritious source of protein and micronutrients (e.g., iron and zinc) for consumers. While beef is a good source of these nutrients on average, there is considerable variation from animal to animal in the concentration of many of these nutrients in beef. Furthermore, beef is perceived as having a high fat content with an undesirable fatty acid composition, i.e., high percentage of saturated fatty acids (SFA). In comparison to other traits, little is known about the amount of variation within these traits that is controlled by the genetics of the animal. It is our goal to develop molecular tools so beef producers can concurrently select for carcass, meat quality and nutrient composition traits. Phenotype (carcass, meat quality, mineral and fatty acid content) and genotype information was collected on 2,285 American Angus cattle. BayesC π was used to estimate the amount of phenotypic variance that could be associated with an animal's genotype and to identify regions of the genome that harbor genetic variation associated with fatty acid content. A substantial amount of phenotypic variance could be associated with genotype for most of the fatty acids. In addition, to the genomic regions containing fatty acid synthase and sterol CoA desaturase, several other regions were found to be associated with fatty acid composition. These results indicate that whole genome selection could be used to select for improved fatty acid composition. This work was supported by Pfizer Animal Genetics.

Key Words: beef, fatty acid, genomics, nutrient content

Growth, Development, Muscle Biology, and Meat Science

138 Effect of feeding 25-hydroxycholecalciferol on gilt performance. J. D. Coffey*¹, E. A. Hines¹, M. A. Vaughn¹, C. W. Starkey¹, T. K. Chung², and J. D. Starkey¹, ¹*Texas Tech University, Lubbock*, ²*DSM Nutritional Products Asia Pacific Pte. Ltd., Singapore*.

To determine the effect of feeding the circulating metabolite of vitamin D, 25-hydroxycholecalciferol (25OHD3, Hy•D[®], DSM Nutritional Products) on circulating 25OHD3 concentrations and gilt performance, a total of 38 PIC Camborough-22 gilts (BW on d -5 = 138 kg) in 4 replicates were randomly assigned to one of 2 corn-soybean meal-based diets. The control diet (CTL) was formulated to contain 2,500 IU D3/kg diet, while the experimental diet (25OHD3) contained 500 IU D3/kg diet + 50 μ g 25OHD3/kg diet. Gilts were fed 2.7 kg of their assigned diet once daily beginning 42 d before breeding. BW were measured on gestational d -5 and 90. Gilts were artificially inseminated with PIC 337-G semen 12 and 24 h after showing signs of estrus. Blood samples were collected from the jugular vein on gestational d -42, -12, 45 and 89 for analysis of circulating plasma 25OHD3 concentration. At gestational d 90 \pm 2, gilts were harvested and reproductive tracts were

removed. Fetal weight, sex, crown to rump length (CRL) as well as the number of mummified fetuses were recorded. Data were analyzed using the MIXED and GLIMMIX procedures of SAS. Circulating plasma concentrations of 25OHD3 were not different among treatment groups at d -42 (CTL = 53.8 ng/mL, 25OHD3 = 57.4 ng/mL; $P = 0.66$). However, gilts fed 25OHD3 had significantly greater ($P < 0.001$) circulating plasma concentrations of 25OHD3 on gestational d -12 (89.7 vs. 56.7 ng/mL), 45 (95.8 vs. 55.7 ng/mL), and 89 (92.8 vs. 58.2 ng/mL) compared with CTL. A 22% numerical increase in pregnancy rate was observed in 25OHD3-fed gilts compared with CTL (77% vs. 55%, respectively; $P = 0.21$). Maternal weight gain (without conceptus), number of mummified and male fetuses, mean fetal weight, and mean fetal CRL were not different ($P > 0.05$) among treatments. Interestingly, feeding 25OHD3 resulted in a 2.5 fetus per litter increase ($P < 0.05$). Overall, feeding 25OHD3 to gilts during gestation resulted in increased circulating plasma 25OHD3 concentrations and increased litter size.

Key Words: pig, litter size, vitamin D

139 Effect of feeding 25-hydroxycholecalciferol on prenatal porcine skeletal muscle development. E. A. Hines^{*1}, J. D. Coffey¹, M. A. Vaughn¹, C. W. Starkey¹, T. K. Chung², and J. D. Starkey¹, ¹Texas Tech University, Lubbock, ²DSM Nutritional Products Asia Pacific Pte. Ltd., Singapore.

To determine the effects of feeding the circulating metabolite of vitamin D, 25-hydroxycholecalciferol (25OHD3, Hy•D[®], DSM Nutritional Products), on prenatal skeletal muscle development, 38 PIC C-22 gilts (BW on d -5 = 138 kg) in 4 replicates were randomly assigned to one of 2 corn-soybean meal-based diets. The control diet (CTL) was formulated to contain 2,500 IU D3/kg diet, while the experimental diet (25OHD3) contained 500 IU D3/kg diet + 50 µg 25OHD3/kg diet. Gilts were fed 2.7 kg of their assigned diet once daily beginning 42 d before breeding. Gilts were artificially inseminated with PIC 337-G semen 12 and 24 h after showing signs of estrus. At gestational d 90 (±2), when fetal muscle fiber number is established, gilts were harvested, fetuses (n = 291) were extracted and a portion of the longissimus muscle (LM) was collected for analysis. Fetal LM were cryosectioned and immunofluorescence stained. Fetal LM area, fiber number, fiber cross-sectional area and number of Pax7+ cells were analyzed using a Nikon inverted fluorescence microscopy system and Elements[®] software. Data were analyzed using the MIXED procedure of SAS with fetus serving as the experimental unit. Regardless of treatment, female fetuses had significantly larger LM areas than males ($P = 0.01$). No treatment difference was observed in fetal LM area ($P = 0.25$). Fetuses from 25OHD3-supplemented gilts had significantly more LM fibers ($P = 0.04$) that tended to be smaller in cross-sectional area compared with CTL fetuses ($P = 0.11$). A numerical increase in the total number of Pax7+ myogenic precursor cells was also observed in fetuses from 25OHD3-supplemented gilts ($P = 0.12$). The combination of additional muscle fibers and Pax7+ myogenic precursor cells could result in enhanced postnatal muscle hypertrophy in the progeny of 25OHD3-supplemented gilts. Overall, these data suggest that feeding 25OHD3 to gilts during gestation may positively impact the red meat yield of their offspring.

Key Words: pig, muscle development, vitamin D

140 Effect of average litter weight on progeny performance, organ and myofiber characteristics. G. Bee^{*1}, S Muller¹, and P. Camilo^{1,2}, ¹Agroscope Liebefeld Posieux, Posieux, Switzerland, ²Institute of Plant, Animal and Agroecosystem Sciences, Zurich, Switzerland.

Recent evidence suggests that different patterns of prenatal survival occurs in normal litter sizes (10–15 total born) resulting in average litter birth weight (BtW) variation of up to 400 g. It was assumed that intrauterine crowding negatively affects BtW, and the characteristics as well as morphometric and myofiber traits from selected offspring of such litters, with low and high average BtW, were compared. From a population of multiparous Swiss Large White sows (parity 2–6), 24 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 sacrificed: from the H-sows those with the medium (HM = 1.73 kg) and lowest (HL = 1.34 kg) BtW and from L-sows those with the medium (LM = 1.26 kg) and highest (LH = 1.55 kg) BtW. Subsequently, internal organs and the longissimus muscle samples were collected and weighed. In the muscle samples histological analyses were performed using mATPase staining after pre-incubation at pH 10.2. The number of pigs born alive was similar ($P = 0.82$; L = 12.1 vs. H = 12.3) but the number of stillborn was higher ($P = 0.02$) in L- than H-sows (2.1 vs. 1.0). Compared with L-sows, offspring of H-sows grew faster (P

< 0.01; 241 vs. 281 g/d) during the lactation period. In the selected offspring, the brain weight expressed relative to the BtW was lower ($P < 0.01$) in HM than LM progeny (2.0 vs. 2.6%) and was lower ($P < 0.01$) in HL than LH progeny (2.6 vs. 2.2%). Fewer ($P < 0.10$) primary and secondary myofibers were observed in the muscle of HM than LM progeny. Due to the numerically greater ($P = 0.13$) number of secondary myofibers in the muscle of HL compared with LH pigs the secondary to primary myofiber ratio was greater ($P = 0.04$; HL = 35.1 vs. LH = 30.5). The observation that L sows had more stillborn pigs and postnatal growth during the lactation period of their offspring was lower is consistent with the notion that these litters were subjected to prenatal programming in utero. Surprisingly, programming had no negative impact on the primary phase of myofiber formation because mid weight pigs of L sows developed more primary myofibers than those of H sows.

Key Words: litter weight, myofiber, litter size, pig

141 Use of electrical stimulation to promote tenderness in the beef round muscles. J. K. Grubbs^{*}, A. N. Fritchen, Y. H. Kim, S. M. Lonergan, and E. Huff-Lonergan, Iowa State University, Ames.

The effect of electrical stimulation (ES) on the tenderization and proteolysis of beef round muscles was investigated. Carcasses from 8 steers were split, one side was a control (NS) and the other was ES within 90 min of exsanguination (100 V, 60 Hz for 1 min). Temperature and pH of *longissimus dorsi* (LD), deep *semimembranosus* (DSM) (inner 1/4 of the muscle), and superficial *semimembranosus* (SSM) (outer 1/4 of the muscle) were recorded at 1.5, 3.5, 5.5, 8.5 and 24 h. At 1 d postmortem the LD, DSM, SSM, *adductor* (AD), and *gracilis* (GR) from each side of the carcasses were removed, cut into steaks, vacuum packaged, and aged at 4°C for 1 or 9 d. Sensory tenderness, star probe, troponin-T (TT) degradation, and µ-calpain autolysis were determined for each muscle and aging time. ES resulted in a more rapid ($P < 0.05$) pH decline of LD during the 24 h postmortem chilling period. Across LD and SM, ultimate pH at 24 h postmortem was not different ($P > 0.05$) between the ES and NS. No temperature differences were observed at any of the recorded time points in either the LD or SSM. The DSM had higher ($P < 0.05$) temperatures than the SSM at all time points except 1.5 h. No difference in instrumental tenderness was detected between ES and NS muscles. Sensory tenderness of ES round muscles after 1 d of aging was greater ($P < 0.05$) compared with NS round muscles. Immunoblotting for TT degradation showed ES had no impact ($P > 0.05$); however degradation increased ($P < 0.05$) with aging regardless of ES, across all muscles. Immunoblotting for µ-calpain autolysis indicated a decrease ($P < 0.05$) in the un-activated form of µ-calpain (80 kDa) in ES DSM. An increase in activated µ-calpain (76 kDa) was seen in the ES SSM, both results indicating more potential proteolysis could occur. No differences in µ-calpain autolysis were seen in the AD, and GR. Low voltage ES accelerates sensory tenderness development and has no effect on proteolysis or instrumental tenderness measurements of either LD or the round muscles.

Key Words: beef round, electrical stimulation, tenderness, µ-calpain

142 Effects of supplementing dried distillers grains with solubles to heavy, yearling stocker cattle during the last 90 days of grazing to improve meat quality traits when utilizing a short feeding protocol. A. Stickel^{*}, T. Houser, J. Drouillard, K. C. Olson, B. Gerlach, L. Weber, B. Goehring, G. Skaar, M. Dikeman, and J. Unruh, Kansas State University, Manhattan.

The purpose of this research was to investigate the impact from feeding dried distillers grains with solubles (DDGS) to heavy stocker cattle during the late grazing season and the impact of a shortened, high concentrate feeding period on meat quality traits. The experimental design was a randomized complete block design with a 2x3 factorial treatment arrangement. Factors consisted of DDGS supplementation during grazing (0 or 1% of BW as DDGS; DM basis) and finishing d on feed (DOF) (75, 100, 125) with 2 replications. Crossbred steers (n = 144; 367 ± 18.46 kg BW) were stratified by weight and randomly assigned to 1 of 12 pastures. Cattle grazed native pastures for 90 d and were then placed into feedlot pens and fed a high concentrate diet. 72 rib and plate sections were collected 24 to 48 h postmortem. Steaks were aged for 14 d and used to evaluate sensory characteristics, lean color, tenderness and fatty acid content. Increasing DOF decreased (Lin; $P < 0.01$) carcass protein %, moisture %, and increased (Lin; $P < 0.01$) carcass fat %. Increasing DOF increased (Lin; $P = 0.01$) L* values, while decreasing (Lin; $P < 0.01$) a* and b* values for external fat color. No differences ($P > 0.05$) were seen between the percentages of SFA, MUFA, PUFA, or CLA for any treatment. Increased ($P = 0.01$) sensory off-flavors were present between 100 and 125 DOF. However, no other differences ($P > 0.05$) were seen for any sensory traits, instrumental tenderness, lean color or fatty acid profile for any treatment. In conclusion, supplementing DDGS to cattle grazing native pasture had no effect on meat quality. Utilizing a short feeding period resulted in minimal effect on meat quality traits, but increasing DOF resulted in a greater amount of whiter external fat, a lower carcass protein %, increased carcass moisture % and increased carcass fat %.

Key Words: beef, color, dried distillers grains with solubles, tenderness

143 (Invited ASAS Animal Science Young Scholar) Effects of immunological castration on boar taint, pork quality, cutting yields, and further processed products. D. D. Boler* and J. Killefer, *University of Illinois, Urbana.*

Immunological castration of pigs is a means of eliminating offensive odors or aromas known as boar taint in cooked pork. The process reduces levels of boar taint compounds (androstenone and skatole) associated with intact males to levels similar to barrows. Trained and consumer sensory panels are unable to detect differences in sensory parameters among barrows, gilts, and immunologically castrated (IC) males. The process involves giving 2.2 mL s.c. injections. The first must be after the pig is at least 9 weeks old and the second must be at least 4 weeks before harvest. Worldwide data indicates feed intake of IC males increases after the second dose and ADG is higher. Feed conversion during the lifetime of the IC male is improved when compared with barrows. This leads to heavier ending live weights. The magnitude of the difference of carcass weights are usually less than live weights because of testicles, scrotal skin and secondary sex organs of IC males which decreases dressing percentage about 2 percentage units. Carcasses from IC males have less fat at the 10th and last rib and have a higher percentage of carcass lean when compared with barrows. Domestic and international data have shown an increase in ham and shoulder weights as a percent of carcass weight. Cutting yields are higher in IC males than barrows and increasing dietary lysine levels improves cutting yields of IC males to an advantage of about 2.5 per-

centage units. This advantage has been shown in pigs harvested 4, 5, and 6, weeks post second injection and in pigs classified as light or heavy ending live weights. There are only minimal differences in pork quality characteristics between IC males and barrows. Bellies from IC males are thinner than bellies from physical castrates, but processing characteristics such as cooked yield are similar between the 2 sexes. There are no differences in PFF values of cured hams between IC males and barrows. Data on carcass lean and cutout values appear to be additive when immunization and ractopamine-HCl are administered to pigs during the same period during the end of the feeding phase. Overall, immunization does not affect pork quality, improves cutting yields, makes fresh bellies thinner, but does not affect cured product characteristics.

Key Words: cutting yield, immunological castration, pork, sensory panels

144 Array analysis of mucosal gene expression in the intestine of rats following ingestion of OmniGen-AF. B. R. Ou2,1, A. Rowson*1, S. Puntenney1, and N. E. Forsberg1, ¹*OmniGen Research, Corvallis, OR,* ²*Tunghai University, Tunghai, Taiwan ROC.*

The goal was to assess effects of feeding OmniGen-AF on gene expression in the rat intestine. Rats (8/treatment) were fed a control diet or one supplemented with OmniGen-AF (0.5% w/w) for 28 d after which they were killed and intestine recovered. RNA was extracted from intestinal samples and its quality was assessed using a Bioanalyzer. RNA was then hybridized to Affymetrix whole rat genome arrays and relative concentrations of approximately 23,000 transcripts in control versus OmniGen-AF-fed rats were compared. The normalization of probe set intensities was performed using the Robust Multiarray Analysis method. To identify differentially expressed genes, expression intensities were compared using a moderated *t*-test and a Bayes smoothing approach. To correct for the effect of multiple testing, the false discovery rate was estimated from *p* values derived from the moderated *t*-test statistics. The analysis was performed using the affyGUI (Graphical User Interface) for the Limma microarray package which is available as part of the Bioconductor software package [www.Bioconductor.org] for the R computing environment. Pathways analysis of the differentially expressed genes was performed using DAVID bioinformatics resources. Of the 23,000 genes represented on the array, 288 genes were upregulated ($P < 0.05$) and 385 were downregulated ($P < 0.05$). Pathway analysis of the data set revealed that the regulated genes clustered into 13 pathways of which most were associated with “immunity.” Immune regulatory pathways which were differentially regulated in the intestine by feeding OmniGen-AF included 1) complement and coagulation cascades, 2) arachidonic acid metabolism, 3) endocytosis, 4) antigen processing and presentation 5) prion diseases, 6) autoimmune thyroid disease, 7) allograft rejection, 8) graft versus host disease and 9) viral myocarditis. Within these pathways, major histocompatibility complex (MHC) was upregulated. MHC is involved in antigen presentation by phagocytic cells and we have previously reported (Rowson et al., 2011) that OmniGen-AF also increased MHC gene expression in mouse mammary tissue. This analysis provides a holistic view of the effects that OmniGen-AF has on a mucosal surface. Perhaps not surprisingly, the constituents of the product bring about changes in gene expression in this tissue.

Key Words: OmniGen-AF, immunity, mucosa, intestine

POSTER PRESENTATIONS

Growth, Development, Muscle Biology, and Meat Science

145 The effects of dietary astaxanthin, ractopamine HCl, and gender on the growth, carcass, and pork color characteristics of finishing pigs. J. R. Bergstrom,* J. L. Nelssen, T. A. Houser, M. D. Tokach, R. D. Goodband, J. M. DeRouchey, and S. S. Dritz, *Kansas State University, Manhattan*.

A total of 144 finishing pigs (initially 102 kg) were used to evaluate the effects of ractopamine HCl (RAC) and various levels and sources of added dietary astaxanthin (AX), on growth, carcass, and pork color characteristics of barrows and gilts. Pigs were blocked by gender and weight and randomly allotted to 1 of 9 dietary treatments fed for approximately 26 d pre-harvest. Dietary treatments consisted of a corn-soybean meal-based control diet, the control diet with 5, 7.5, or 10 ppm AX from *Phaffia rhodozyma* yeast, the control diet with 5 ppm synthetic AX, and the control diet with 10 ppm RAC and 0, 2.5, 5, and 7.5 ppm AX from *Phaffia rhodozyma* yeast. There were 2 pigs per pen and 8 pens per treatment (4 pens per treatment × gender combination). Overall, barrows had greater ($P < 0.01$) ADG and ADFI than gilts, while ADG and final BW increased ($P < 0.01$) and G:F improved for pigs fed RAC. For carcass characteristics, barrows had greater ($P < 0.01$) backfat depth and less ($P < 0.01$) longissimus muscle area and fat-free lean than gilts. Pigs fed RAC had greater ($P < 0.01$) HCW, yield, and longissimus muscle area than those not fed RAC. Growth performance and carcass characteristics of pigs fed AX were not different than control pigs. Although there were no differences in the initial NPPC color scores, discoloration scores of longissimus chops increased (linear, $P < 0.01$) daily during 7 d of retail display, and were greater ($P < 0.01$) for barrow chops on d 7 compared with gilt chops (gender × d interaction, $P < 0.01$). Also, the overall average discoloration scores and d 0 to 3 objective total color change ($\Delta E = \sqrt{[\Delta CIE L^*]^2 + [\Delta CIE a^*]^2 + [\Delta CIE b^*]^2}$) were lower ($P < 0.01$) for longissimus chops from gilts and pigs fed RAC, although the difference between gilts and barrows was smaller when they were fed RAC (gender × treatment interaction, $P < 0.01$). Modest differences in instrumental measures (CIE L^* , a^* , b^*) of longissimus chop color were associated with added dietary AX during retail display, but these did not result in an increase in color shelf-life or reduction in the objective measure of total color change. Collectively, these observations indicated a greater ($P < 0.01$) color shelf-life for chops from gilts and pigs fed RAC.

Key Words: astaxanthin, pigs, pork color

146 The effects of dietary astaxanthin and ractopamine HCl on the growth and carcass characteristics of finishing pigs, and the color shelf-life of longissimus chops from barrows and gilts. J. R. Bergstrom, T. A. Houser, G. R. Skaar,* J. L. Nelssen, M. D. Tokach, R. D. Goodband, J. M. DeRouchey, and S. S. Dritz, *Kansas State University, Manhattan*.

A total of 160 pigs (initially 90.4 kg) were used to evaluate the effects of increasing dietary astaxanthin (AX, from *Phaffia rhodozyma* yeast) and ractopamine HCl (RAC) on the growth and carcass characteristics of finishing pigs, and the color shelf-life of longissimus muscle (LM) chops from barrows and gilts. Pigs were weighed and randomly allot-

ted to 1 of 8 dietary treatments fed for approximately 26 d pre-harvest. Dietary treatments consisted of a corn-soybean meal-based control diet, the control diet with 7.5, 15, 30, 60, or 120 ppm AX, and a corn-soybean meal-based diet with 10 ppm RAC and 7.5 or 20 ppm AX. There were 2 pigs (1 barrow and gilt) per pen and 10 pens per treatment. A split-plot design with repeated measures was used to compare color characteristics of LM chops from individual barrows and gilts. Overall, pigs fed RAC had increased ($P < 0.01$) ADG, final BW, and G:F compared with pigs not fed RAC. Among pigs not fed RAC, there was improved (quadratic, $P < 0.05$) G:F and a trend (quadratic, $P < 0.06$) for increased ADG with increasing AX to 60 ppm. For carcass characteristics, pigs fed RAC had greater ($P < 0.03$) HCW, 10th-rib LM area, 24-h LM pH, and fat-free lean index than those not fed RAC treatments. Among pigs not fed RAC, there was a trend (quadratic, $P < 0.07$) for increased yield with increasing AX. During 6 d of retail display, the initial (d 0) NPPC color score of LM chops from gilts was greater ($P < 0.03$) than that of chops from barrows. Subjective discoloration scores of LM chops did not differ initially, but increased (linear, $P < 0.01$) daily, and were greater ($P < 0.02$) on d 6 for chops from barrows and pigs not fed RAC compared with chops from gilts and pigs fed RAC (gender × d and treatment × d interactions, $P < 0.04$). The CIE a^* and CIE b^* of LM chops decreased (linear, $P < 0.01$) during retail display, and chops from gilts and pigs fed RAC had lower ($P < 0.04$) CIE b^* than chops from barrows and pigs not fed RAC, especially on d 0 (gender × d and treatment × d interaction, $P < 0.01$). Overall (d 0 to 6), discoloration score and change in objective total color (ΔE) were lower ($P < 0.02$) for LM chops from gilts and pigs fed RAC. These observations suggest that color shelf-life was extended for chops from gilts and pigs fed RAC.

Key Words: astaxanthin, pigs, pork color

147 Corn distillers solubles does not affect beef quality. K. Varnold,* A. Haack, J. Hergenreder, S. Pokharel, L. Senaratne, A. Pesta, G. Erickson, and C. Calkins, *University of Nebraska, Lincoln*.

When distiller's grains with solubles are fed to cattle they can cause the meat to have a decreased shelf life and an increased susceptibility to oxidation. The objective was to determine if the same detrimental effects would be seen if only corn distiller's solubles (CDS) were fed. Cattle ($n = 250$) were fed 1 of 5 levels of CDS (0, 9, 18, 27, and 36%, on a DM basis) for 132 d. No distiller's grains were added to the corn-based diets. After harvest, 75 strip loins, 15 from each treatment, grading USDA Choice or higher were selected and shipped to the University of Nebraska's Meat Laboratory where they were aged for 14 d. After aging, 3 steaks from each strip loin were placed in retail display for 0, 4, and 7 d to be used to measure oxidation. At the end of the retail display period, steaks were powdered and oxidation was measured by quantifying thiobarbituric acid reactive substances (TBARS). The 7 d retail display steaks were also used for objective measurement of color and subjective evaluation of discoloration, with readings performed every day. Data were analyzed using PROC Mixed of SAS with repeated measures. Overall, there were no differences between

treatments for discoloration scores, objective color measurements (L*, a*, and b*), and oxidation values ($P = 0.95$, $P = 0.31$, $P = 0.41$, $P = 0.30$, and $P = 0.19$, respectively). Feeding cattle up to 36% CDS has the same effect on meat quality as feeding an all-corn diet. These data suggest that the soluble fraction is not responsible for the negative effects that are seen in meat quality when cattle are fed distiller's grains with solubles.

Key Words: corn distillers solubles, beef, meat quality

148 Effect of feeding diets containing corn dried distillers grains with solubles (DDGS) with and without tallow on bacon yield and quality. R. J. LaBerge,* K. M. McClelland, J. M. Pomeranke, G. C. Shurson, P. C. Nelson, T. J. McNamara, and R. B. Cox, *University of Minnesota, St. Paul.*

This study evaluated the effects of diets containing 30% DDGS with or without 5% tallow fed to grower-finisher pigs on bacon yield and quality. Crossbred pigs ($n = 315$) were blocked by initial BW (32.4 ± 1.89 kg) and fed one of 4 diets in a 3-phase feeding program using a 2×2 factorial arrangement. Dietary treatments consisted of a conventional corn-soybean meal diet (C), C with 5% tallow (T), C with 30% DDGS (D), or C with T and D (DT). Pigs were randomly assigned to one of 40 pens (10 pens/trt; 7–8 pigs/pen) and one pig closest to the mean weight in each pen ($n = 20$ barrows and 20 gilts) was selected and harvested, with the anterior half of each belly selected for processing and analysis. Bellies were cured, tumbled, smoked, and sliced at 9 slices per 2.54 cm. Weights were taken pre- and post-tumbling, post-smoking, and post-slicing. Sliced slabs were divided into 5 equal sections. The first 2 slices serially from the anterior end of each section were evaluated for shatter analysis using a subjective scale of 1 to 6 (1 = no shatter; 6 = extreme shatter). Two more slices from each section were saved for cook loss, cook shrink and cook distortion determinations. Slices were cooked on a 157°C surface to target $\leq 40\%$ loss of the original weight. Cook shrink was determined by measuring slice length pre- and post-cooking. Cook distortion was evaluated using a subjective scale of 1 to 5 (1 = no distortion; 5 = severe distortion). Bellies from DT were heavier ($P = 0.02$) than D bellies. Bellies from T ($P = 0.04$) and D ($P = 0.03$) weighed less post-tumbling than DT bellies. Smokehouse yield was lower for D bellies ($P = 0.04$) compared with DT bellies and D bacon had higher ($P = 0.04$) shatter scores than C bacon. No differences were found in slicing yield, distortion, cook loss or cook shrink among treatments. Although there were small differences in belly yields, slicing yield and bacon quality characteristics were unaffected by including 30% DDGS with or without 5% tallow in swine grower-finisher diets.

Key Words: DDGS, bacon, tallow

149 Effect of low fat dried distillers grains on consumer sensory characteristics of Longissimus strip steaks and cooked sausage. J. M. Popowski,* J. M. Kelzer, G. I. Crawford, A. DiCostanzo, and R. B. Cox, *University of Minnesota, Twin Cities.*

The experiment evaluated sensory characteristics of strip steaks and summer sausage from 48 steers fed dietary treatments that included either a conventional corn-based finishing diet (CON); CON containing 35% dried distillers grains with solubles (DDGS); or CON containing 35% low fat dried distillers grains (LFDG). Beef strip loins (IMPS #180), and shoulder clods (IMPS #114) were removed from the carcass 24h postmortem. Three, 2.54cm steaks were serially cut from

the anterior of each strip loin, individually vacuum packed, and frozen (-20°C). Steaks were thawed at 4°C for 36 h and cooked in an electric oven (180°C) to an internal temperature of 71°C and cut into cubes (1cm x 1cm x 1cm). Shoulder clods were ground twice (0.375cm) and 3 composite meat blocks were blended (4 animals/treatment). Blended meat blocks were mixed with seasoning and culture and stuffed into fibrous casings, smoked, and cooked to an internal temperature of 71°C , chilled (4°C) and sliced (0.3cm thickness and 6.4 cm in diameter). Sensory evaluation on steaks and summer sausage was carried out by an untrained consumer panel. Consumers rated overall liking, flavor liking, and texture liking on 120 point labeled affective magnitude scales, with the left-most end labeled strongest dislike and the right-most end labeled strongest like for steak and summer sausage. Off-flavor, juiciness (steak), sourness (summer sausage), and toughness ratings were made on a 20 point line scale, with the left most end labeled none and right most end labeled extremely intense for all treatments and replications.

Table 1.

Steak (n=108)	CON	LFDG	DDGS	P-Value
Overall Liking	71.5	68.6	70.5	0.10
Flavor Liking	71.3 ^a	68.1 ^b	70.2 ^{ab}	0.05
Texture Liking	68.8	68.3	70.5	0.47
Toughness	7.2	7.1	6.6	0.17
Juiciness	7.7	8.4	7.8	0.10
Off-Flavor	4.3	4.6	4.3	0.20
Summer Sausage (n=101)				
Overall Liking	70.0 ^a	68.1 ^{ab}	66.2 ^b	0.01
Flavor Liking	70.6 ^a	69.1 ^{ab}	67.4 ^b	0.04
Texture Liking	64.8 ^a	64.1 ^a	61.0 ^b	0.01
Toughness	5.7 ^a	6.1 ^b	5.2 ^c	<0.01
Sourness	5.2	5.0	4.7	0.15
Off Flavor	4.4	4.8	4.8	0.16

^{abc}Means lacking a common superscript letter differ significantly (<0.05).

Key Words: low fat distillers, beef steaks, beef cooked sausage, sensory

150 Effect of intermittent feeding of diets containing 40% corn dried distillers grains with solubles (DDGS) to growing-finishing pigs on bacon yield and quality. R. J. LaBerge*¹, K. M. McClelland¹, A. M. Hilbrands², L. J. Johnston², G. C. Shurson¹, P. C. Nelson¹, T. J. McNamara¹, and R. B. Cox¹, ¹University of Minnesota, St. Paul, ²University of Minnesota, West Central Research and Outreach Center, Morris.

This study evaluated the effects of feeding 40% DDGS diets to growing-finishing pigs, as well as, the accuracy of Standardized Ileal Digestible (SID) AA estimates of DDGS sources when fed continuously or intermittently throughout the growing-finishing phase on bacon quality and yields. Crossbred pigs ($n = 324$) were blocked by initial BW (33.2 ± 3.0 kg), and pens within a block were assigned randomly to 1 of 6 dietary treatments (6 pens/trt; 9 pigs/pen). Diets included a corn-soybean meal control (C), C plus 40% low AA digestible DDGS (Lo), C plus 40% high AA digestible DDGS (Hi), alternating between Lo and C (Lo-C), Hi and C (Hi-C), and Hi and Lo (Hi-Lo). Diet switches coincided with phase changes and pigs were harvested on a single date after 98 d on feed. Carcasses ($n = 33$) representing pigs fed the Lo, Hi-C, and Hi-Lo

treatments (11 per trt) were randomly selected for further processing and analysis. Vertical flex tests were conducted and belly thickness was measured and averaged from 8 locations. Bellies were cured, tumbled, smoked, and sliced (9 slices per 2.54 cm). Weights were obtained pre- and post-tumbling, post-smoking, and post-slicing. Sliced slabs were divided into 5 equal sections, and the first 2 slices from the anterior end of each section were removed for shatter analysis using a subjective scale of 1 to 6 (1 = no shatter; 6 = extreme shatter). The next 2 slices serially were evaluated for cook loss, cook shrink and cook distortion and were cooked on a 157°C surface to target $\leq 40\%$ loss of the original

weight. Cook shrink was determined by measuring slice length pre- and post-cooking. Cook distortion was determined using a subjective scale of 1 to 5 (1 = no distortion; 5 = severe distortion). No differences were observed for belly thickness, green weight, tumble yield, smokehouse yield, slicing yield, shatter analysis, distortion, cook loss, or cook shrink among treatments. Results indicate feeding DDGS had no adverse effect on bacon quality or yield and feeding DDGS at levels up to 40% of the diet should not affect bacon quality.

Key Words: DDGS, swine, bacon

SYMPOSIA AND ORAL SESSIONS

Nonruminant Nutrition: Co-product Feedstuffs

151 Effects of wheat middlings and choice white grease (CWG) in diets on the growth performance, carcass characteristics, and carcass fat quality in growing-finishing pigs. J. A. Barnes,* J. M. DeRouchey, M. D. Tokach, R. D. Goodband, S. S. Dritz, and J. M. Nelssen, *Kansas State University, Manhattan.*

A total of 288 pigs (42.3 kg BW) were used in an 87-d study to determine the effects of wheat middlings and CWG on growth performance, carcass characteristics, and carcass fat quality of finishing pigs. Pens of pigs were randomly allotted by weight and gender to 1 of 6 dietary treatments (6 pens/treatment). Treatments were arranged in a 2 × 3 factorial with main effects of wheat middlings (0 or 20%) and CWG (0, 2.5, or 5%). Diets were corn-soybean meal-based with 15% dried distillers grains with solubles and fed in 4 phases with constant SID lys:ME within each phase. There were no CWG × wheat middlings interactions ($P \geq 0.12$) for any of the criteria evaluated. Overall, (d 0 to 87), feeding 20% wheat middlings decreased ($P < 0.001$) ADG and G:F. Pigs fed diets with increased CWG had increased ADG (quadratic, $P < 0.03$) and G:F (linear, $P < 0.01$). Pigs fed diets containing 20% wheat middlings had decreased ($P < 0.01$) final BW; while there was a tendency for increased final BW ($P < 0.09$) as dietary CWG increased. Pigs fed wheat middlings had decreased carcass yield ($P < 0.05$), HCW ($P < 0.003$), BF depth ($P < 0.04$), and loin depth ($P < 0.001$), while jowl fat iodine value increased ($P < 0.001$). Additionally, pigs fed CWG had a tendency for increased BF depth (linear, $P < 0.06$) and increased (linear, $P < 0.01$) jowl fat iodine value. The lower dietary energy and decreased bulk density of diets with wheat middlings reduced pig performance, carcass yield and weight, and increased jowl fat IV. Increasing diet energy with CWG can help mitigate the negative effect on live performance; however, additional energy from CWG does not eliminate the negative impact of wheat middlings on carcass yield, carcass weight, and jowl IV.

Table 1.

Wheat middlings, %	0	0	0	20	20	20	SEM
Fat, %	0	2.5	5.0	0	2.5	5.0	
ADG, kg	1.05	1.05	1.08	0.99	0.98	1.04	0.013
ADF, kg	3.06	3.03	3.04	3.07	2.97	3.00	0.046
G:F	0.344	0.347	0.357	0.322	0.332	0.347	0.004
Final BW, kg	133.8	135.2	136.9	128.2	128.9	132.8	2.155
Carcass yield, %	73.3	73.9	73.4	72.8	72.9	72.8	0.407
HCW, kg	98.1	99.9	100.5	93.4	94.0	96.7	1.797
Lean, % ^a	52.9	52.2	52.4	52.6	52.4	52.2	0.298
Backfat, mm ^a	21.3	22.7	22.3	20.0	20.3	21.8	0.723
Loin depth, mm ^a	65.4	64.1	64.2	61.6	61.0	62.9	0.694
Jowl IV	71.6	72.4	72.3	73.4	73.7	75.1	0.343

^aadjusted to a common HCW.

Key Words: DDGS, pig, wheat middlings

152 Effects of corn dried distillers grains with solubles (DDGS) and increasing wheat middlings on growth performance, carcass traits, and fat quality in growing-finishing pigs. J. A. Barnes,* J.

M. DeRouchey, M. D. Tokach, R. D. Goodband, S. S. Dritz, and J. L. Nelssen, *Kansas State University, Manhattan.*

A total of 288 pigs (46.6 kg initial BW) were used in an 84-d growth trial to evaluate the effects of wheat middlings and corn DDGS on growing-finishing pig growth performance, carcass traits, and fat quality. Pens of pigs were balanced by initial weight and gender and randomly allotted to 1 of 4 treatments with 8 pigs per pen (4 barrows and 4 gilts) and 9 pens per treatment. Treatments included a corn-soybean meal-based control diet, the control diet with 30% DDGS, or the diet with 30% DDGS plus 10% or 20% wheat middlings. Diets were fed in 4 phases, and formulated to constant SID lys:ME within each phase. Overall, pigs fed increasing wheat middlings had decreased (linear; $P \leq 0.02$) ADG and poorer (linear; $P \leq 0.01$) G:F and tended to decrease final BW (linear; $P \leq 0.07$). There were no differences ($P = 0.68$) in ADFI. Feeding 30% DDGS did not influence growth performance ($P > 0.11$). For carcass traits, increasing wheat middlings decreased (linear; $P < 0.01$) carcass yield and HCW and tended to decrease (linear; $P < 0.06$) loin depth. Pigs fed wheat middlings had decreased (quadratic; $P < 0.02$) BF and increased (quadratic; $P < 0.01$) percentage lean. Pigs fed 30% DDGS had decreased ($P < 0.03$) carcass yield and BF depth ($P < 0.01$), while increasing percentage lean ($P < 0.03$) and jowl fat IV ($P < 0.001$). Adding wheat middlings to the diet did not ameliorate the negative effects of DDGS on jowl fat IV value. Ingredients such as DDGS and wheat middlings can reduce feed cost; however, the impact on growth and carcass quality must be understood to determine net profitability.

Table 1

DDGS, %	0	30	30	30	SEM
Wheat middlings, %	0	0	10	20	
ADG, kg/d ^b	1.05	1.04	1.00	0.99	0.014
ADFI, kg/d	3.22	3.11	3.10	3.09	0.046
G:F ^b	0.327	0.333	0.324	0.322	0.003
Final BW, kg	134.9	133.8	131.0	129.8	1.50
Carcass yield, % ^{ab}	74.2	73.4	72.7	72.1	0.27
HCW, kg ^b	100.1	98.1	95.3	93.6	1.12
Lean, % ^{acd}	51.0	51.7	51.0	51.7	0.002
Backfat, mm ^{acd}	24.9	22.9	24.0	21.9	0.58
Loin depth, mm ^d	61.3	61.5	59.9	60.0	0.56
Jowl IV ^a	70.6	76.5	76.0	77.4	0.56

^aDDGS differ (yes vs. no), $P < 0.05$. ^bWheat midds differ, Linear $P < 0.05$. ^cWheat midds differ, Quadratic $P < 0.05$. ^dadjusted for common HCW.

Key Words: DDGS, pig, wheat middlings

153 Effects of tallow and DDGS on pig performance and carcass characteristics. J. M. Pomeroy,*¹, G. C. Shurson¹, S. K. Baidoo², and L. J. Johnston³, ¹University of Minnesota, St. Paul, ²Southern Research and Outreach Center, Waseca, MN, ³West Central Research and Outreach Center, Morris, MN.

A study was conducted to determine the effect of supplementing 5% beef tallow to grower-finisher diets containing 30% corn dried distillers grains with solubles (DDGS) on pig performance and carcass characteristics. Crossbred pigs ($n = 315$) were blocked by initial BW (32.4 ± 1 . Nine kg) and assigned randomly to 1 of 4 dietary treatments in a 3-phase feeding program using a 2×2 factorial arrangement of treatments. Pigs were housed in a confinement facility containing 40 pens measuring 2.0 m x 3.0 m with 7 to 8 pigs per pen to provide 10 replications per treatment. Gilts and barrows were housed separately, but fed common diets formulated to contain similar available P and Standardized Ileal Digestible Lys:ME across treatments. Diets consisted of a conventional corn-soybean meal diet (C), C containing 30% DDGS (D), C containing 5% tallow (T), and C with 30% DDGS and 5% tallow (DT). Data were analyzed using the Proc Mixed functions of SAS with random effect of block and fixed effects of DDGS, tallow, gender, and DDGS \times tallow. Barrows had higher ADG, ADFI, and backfat, and lower G:F, and carcass lean % than gilts ($P < 0.01$). Overall ADG did not differ among treatments, but ADFI was higher for pigs fed C and D (2.8 and 2.8 kg, respectively) due to lower caloric density compared with T and DT (2.6 and 2.5 kg, respectively; $P < 0.01$). Consequently, pigs fed T and DT had higher ($P < 0.01$) G:F (0.40 and 0.41, respectively) than those fed C and D (0.37 and 0.37, respectively). Dietary treatment did not affect HCW. Carcass yield was greater for pigs fed T and DT (79.5 and 79.4%, respectively) compared with pigs fed C and D (78.8 and 78.3%, respectively; $P < 0.01$). Backfat depth was reduced for pigs fed DDGS diets ($P < 0.02$), but increased for pigs fed tallow diets ($P < 0.01$). There was a DDGS \times tallow interaction for carcass lean percent ($P < 0.04$) indicating that tallow decreased carcass lean, but the addition of DDGS improved carcass lean. In summary, adding 5% tallow to 30% DDGS diets improved G:F and carcass yield, but increased backfat depth and reduced the percentage of carcass lean.

Key Words: DDGS, tallow, growth performance, carcass characteristics

154 Effects of feeding strategies of corn distillers dried grains with solubles (DDGS) on finisher performance, carcass, and bacon sensory measures. R. W. Fent,* R. E. Martin, M. R. Widmer, D. O. Liptrap, and J. S. Knott, *Ralco Nutrition, Inc., Marshall, MN*.

A total of 987 pigs (28.5 kg BW) were penned at 20–21 pigs per pen for a finisher experiment evaluating feeding strategies for corn distillers dried grains with solubles (DDGS). Pens were allotted to one of 4 treatments in a completely randomized design with 11–12 replicates per treatment. Treatment 1 (T1) consisted of DDGS feeding levels of 15, 20, 20, 20, 10, and 0% for the 6 feeding phases. Treatment 2 (T2) included DDGS at 20% of the diet throughout the experimental period. Treatment 3 (T3) included 20, 30, 30, 30, 10, and 0% DDGS and treatment 4 (T4) included 20, 40, 40, 40, 10, and 0% DDGS for the 6 feeding phases, respectively. All diets (meal-form) were corn-soybean meal-DDGS-based with no added fat and formulated to equal SID Lys and NE concentrations within each phase. Growth performance was evaluated until 20% of the pens averaged more than 116 kg per pig. Treatments were fed until marketing. Carcass data (Fat-o-Meter) was collected on 553 pigs consisting of equal numbers of pigs per treatment on each date marketed at an average of 112 d on feed. An additional 2 pigs per pen were utilized for collection of loin quality, belly and bacon quality, and sensory analysis. No statistical treatment differences ($P > 0.10$) in ADG, ADFI, G:F, backfat, loin depth, or percent lean were observed. However, T4 had numerically the least ADG, ADFI, and final BW. Treatment 1 resulted in greater ($P < 0.05$) carcass yield and loin marbling score than T3 and T4. Bacon flavor intensity

was affected ($P < 0.02$) by dietary treatment. T4 and T2 resulted in less bacon flavor intensity ($P < 0.10$) than T1 and T3. The greatest ($P < 0.08$) bacon crispiness was observed for T2 and the least crispiness attributed to T3. These DDGS feeding strategies generally resulted in similar growth performance and carcass measures. The withdrawal of DDGS in the last dietary phase did not alleviate a reduction in carcass yield in the high DDGS diets. Very few differences existed in loin quality and bacon analyses.

Key Words: DDGS, pigs, yield

155 Effects of increasing distillers dried grains with solubles (DDGS) on nutrient excretion during the finishing phase. H. J. Kim,* S. Carter, T. Walraven, and M. Bible, *Oklahoma State University, Stillwater*.

A total of 80 crossbred pigs was used to determine the effects of increasing DDGS on nutrient excretion during the finishing phase (37 to 135 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 BW, sex, and ancestry, and randomly assigned to one of 4 rooms. Diets were randomly allotted in 4×4 Latin square design with 4 rooms and 4 dietary phases. The 4 dietary treatments included fortified corn-soybean meal based diets containing 0, 10, 20 or 40% DDGS (88% DM, 27.8% CP, 0.08% Ca, 0.8% P, 0.32% Mg, 0.75% S) which replaced corn, soybean meal, and dicalcium phosphate. Crystalline Lys was used to limit the increase in dietary CP for diets containing DDGS and Trp was added as needed to maintain ratios in all phases. All diets, within the 4 dietary phases, were balanced on SID Lys (0.92, 0.79, 0.65, 0.56%) and digestible P (0.23, 0.22, 0.21, 0.21%). Each phase consisted of a 1-wk adjustment period followed by a 3-wk slurry collection period. Inclusion of 10 or 20% DDGS had little effect on ADG or G:F, but 40% DDGS reduced performance (quad, $P < 0.05$). However, DDGS did not affect ADFI. Slurry pH (7.50, 7.37, 7.39, 7.22) decreased (linear, $P < 0.01$) and volume increased ($P = 0.02$) as DDGS increased. The daily intakes of N ($P < 0.09$), Mg and S ($P < 0.01$) were increased linearly with increasing DDGS. However, P intake decreased (linear; $P < 0.07$), but DDGS did not affect DM and Ca intakes. Excretion (g/d) of DM (299, 358, 406, 494), N (22.6, 26.7, 28.7, 32.7), Mg (3.19, 3.95, 4.28, 5.09), and S (2.87, 4.20, 5.23, 8.03) were increased (linear; $P < 0.01$) by 165, 145, 159, and 279% for pigs fed 40% DDGS. Increasing DDGS slightly increased (linear, $P = 0.10$) P excretion (8.26, 9.15, 9.56, 9.84 g/d), but did not affect Ca and K excretion. In conclusion, increasing DDGS in the diet markedly increases DM, N, and S excretion by finishing pigs. This work was partially funded by NPB.

Key Words: pigs, distillers dried grains with solubles, nutrient excretion

156 Impact of DDGS particle size on nutrient digestibility, DE and ME content, and flowability in diets for growing pigs. P Liu*¹, L. W. O. Souza¹, S. K. Baidoo², and G. C. Shurson¹, ¹University of Minnesota, Saint Paul, ²Southern Research and Outreach Center, Waseca, MN.

A study was conducted to evaluate the effects of particle size of corn distillers grains with solubles (DDGS) on DE and ME content, and DM, GE, N, and P digestibility and flowability of diets for growing pigs. One DDGS source with mean particle size of 818 μm (CDG) was further processed in separate batches to achieve a mean particle size

of 595 μm (MDG) and 308 μm (FDG). The control diet consisted of corn (96.8%) with supplemental minerals and vitamins, and 3 additional diets containing 30% CDG, MDG, or FDG as a replacement for corn. Thirty 6 growing pigs were assigned to 1 of 4 treatments in a RCB design based on their initial BW (40 ± 1.13 kg), housed in individual metabolic crates, and fed a daily amount of their respective diets equivalent to 3% BW for a 9 d adaptation followed by a 4 d total collection of feces and urine. Feed, feces, and urine samples were analyzed for DM, GE, N, and P, to calculate diet nutrient digestibility, and DE and ME content of corn and CDG, MDG, and FDG. Diet drained and poured angles of repose were measured using a modified Hele-Shaw cell to evaluate the diet flowability. Dry matter digestibility was higher ($P < 0.01$) in corn than in DDGS, and was improved for FDG compared with CDG ($P < 0.05$), but MDG was not different from CDG and FDG. The DE and ME content of FDG (3,709 and 3,577 kcal/kg, respectively) was higher ($P < 0.05$) than CDG (3,487 and 3,345 kcal/kg, respectively), with MDG being intermediate (3,681 and 3,507 kcal/kg, respectively). No differences were observed for N and P digestibility among 3 DDGS particle size diets. No differences were observed for percentage of N retained between the corn and DDGS diets but feeding the DDGS diets resulted in higher daily P retention ($P < 0.0002$) than the corn diet. Adding FDG to the diet reduced ($P < 0.05$) diet flowability, as indicated by a higher drained angle of repose, compared with MDG and CDG. These results suggested that for each 25 micron decrease in DDGS particle size from 818 μm to 308 μm , ME contribution from DDGS to the diet is 13.6 kcal/kg DM, but diet flowability will be reduced.

Key Words: DDGS, particle size, energy, flowability

157 Antioxidant improves growth performance of growing-finishing pigs fed a high DDGS diet. R. J. Harrel*, J. Zhao, and G. Reznik, *Novus International Inc., St. Charles MO.*

The utilization of co-products for livestock feeds, such as dried distillers grains with solubles (DDGS), has increased dramatically in recent years. Often with co-products, limits on inclusion rates occur because animal performance declines with higher levels of DDGS and could be potentially caused by antinutritional factors, toxins, lower net energy levels, poor amino acid profile, and unstabilized fat. The objective was to improve pig performance fed high levels of DDGS with a dietary antioxidant (AOX as AGRADO[®]Plus, Novus International). At 38.8 ± 0.7 kg bodyweight, approximately 750 pigs were blocked by weight and pen ($n = 30\text{--}32$ pigs/pen) was randomly assigned to corn-SBM, 60% DDGS, or 60% DDGS + AOX for 85 d (8 pens/treatment). Bodyweights were lower for pigs fed the 60% DDGS diets at 29 and 63 d ($P < 0.01$) and tended to be lower on 85 d of study ($P = 0.06$) compared with the corn-SBM fed pigs. Bodyweights of pigs fed the 60% DDGS + AOX were not different than corn-SBM fed pigs at d 85 ($P > 0.60$). No differences were detected in ADFI during any period between treatments ($P > 0.23$). ADG was reduced 5.7% in pigs fed 60% DDGS to 63 d compared with corn-SBM fed pigs ($P < 0.01$) and pigs fed the 60% DDGS + AOX were not different than pigs fed corn-SBM ($P > 0.11$). The GF was not affected by treatment from 0 to 29 d ($P > 0.52$), but from 29 to 63, GF was reduced by 5.4% in pigs fed 60% DDGS compared with corn-SBM fed pigs ($P = 0.05$). Pigs fed the 60% DDGS + AOX were intermediate in GF from 29 to 63 d ($P = 0.17$) and had higher GF than pigs fed corn-SBM from 63 to 85 d ($P < 0.05$). In summary, feeding high levels of DDGS reduced pig performance and dietary supplementation of an AOX improved performance in high DDGS diets.

Table 1.

Item	Corn-SBM	60% DDGS	60% DDGS + AOX	SEM
ADG, g/d				
0 to 29 d	855 ^a	806 ^b	832 ^{ab}	10
29 to 63 d	952 ^a	898 ^b	924 ^{ab}	12
63 to 85 d	848	885	891	19
0 to 85 d	892 ^x	863 ^y	884 ^{xy}	10
Gain:Feed				
0 to 29 d	0.420	0.410	0.412	0.011
29 to 63 d	0.354 ^a	0.335 ^b	0.341 ^{ab}	0.006
63 to 85 d	0.304 ^b	0.316 ^{ab}	0.321 ^a	0.005
0 to 85 d	0.358	0.350	0.354	0.005

^{ab} $P < 0.05$, ^{xy} $P < 0.10$.

Key Words: antioxidant, DDGS, swine

158 Energy, CP, and AA digestibility of wheat, triticale, and corn distillers dried grains with solubles and digesta and feces VFA content in grower-finisher pigs. K. Kandel^{1*}, E. Beltranena^{1,2}, J. Yanez¹, and R. T. Zijlstra¹, ¹University of Alberta, Edmonton, AB, Canada, ²Alberta Agriculture and Rural Development, Edmonton, AB, Canada.

Wheat distillers dried grains with solubles (DDGS) is a co-product from the ethanol industry with limited information on energy and AA digestibility and fiber fermentability in the pig intestine. Nutrient digestibility and VFA content in digesta and feces were measured in 2 studies. In Exp. 1, 8 ileal-cannulated barrows (BW 80 kg) were fed 4 diets in a double 4×4 Latin square: wheat, wheat+wheat DDGS, wheat DDGS, and N-free. Nutrient digestibility of wheat DDGS was determined by difference from either the wheat or the N-free diet. Apparent total tract digestibility (ATTD) of energy for wheat DDGS was lower ($P < 0.01$) using the wheat diet than the N-free diet (66.0 vs. 68.8%, respectively). The standardized ileal digestibility of Lys for wheat DDGS was similar between the 2 methods (77.3 and 77.9%, respectively). Total VFA in ileal digesta and feces was higher ($P < 0.05$) for pigs fed wheat than DDGS diets. In Exp 2, 5 ileal-cannulated barrows (BW 29 kg) were fed 1 of 5 diets, wheat, wheat+wheat DDGS plant T, wheat+wheat DDGS plant L, wheat+triticale DDGS and wheat+corn DDGS, in a 5×5 Latin square. The ATTD of energy and AID of CP was lower ($P < 0.05$) for DDGS than wheat (62.2 vs. 84.2% and 69.7 vs. 80.2%, respectively). The DE content was higher ($P < 0.05$) for corn DDGS than wheat or triticale DDGS. The SID of Lys was higher ($P < 0.01$) in wheat than DDGS and did not differ among DDGS sources. The SID of Thr was higher ($P < 0.05$) in wheat than DDGS, and for the DDGS was highest for wheat DDGS plant L, intermediate for corn and wheat DDGS plant T, and lowest for triticale DDGS. Total VFA in ileal digesta and feces was highest ($P < 0.05$) for the wheat diet and did not differ among DDGS diets. In conclusion, DDGS differs in energy digestibility depending on cereal of origin. The low VFA content in digesta and feces indicate that DDGS of all sources does not contain much fermentable fiber.

Key Words: DDGS, digestibility, pig, volatile fatty acid

159 Effects of corn germ, tallow, palm kernel oil, or glycerol on fat quality of pigs fed diets containing distillers dried grains with solubles. J. W. Lee,* B. D. Keever, J. Killefer, F. K. McKeith, and H. H. Stein, *University of Illinois, Urbana.*

An experiment was conducted to test the hypothesis that dietary corn germ, tallow, palm kernel oil, or glycine will improve fat quality in pigs fed diets containing distillers dried grains with solubles (DDGS). Thirty 6 barrows and 36 gilts (initial BW: 43.7 ± 2.02 kg) were individually housed and randomly allotted to 1 of 6 dietary treatments in a 2×6 factorial design with 2 genders, 6 dietary treatments, and 12 replicate pigs per diet. A corn-soybean meal control diet and a diet containing corn, soybean meal, and 30% DDGS were formulated. Four additional diets were formulated by adding 15% corn germ, 3% tallow, 3% palm kernel oil, or 5% glycerol to the DDGS-containing diet. There were no effects of diet on ADG, ADFI, or G:F, but barrows had greater ($P < 0.05$) ADG and ADFI, but less ($P < 0.05$) G:F, than gilts. There were no effects of diet on live weight, hot carcass weight, dressing percentage, backfat thickness, or fat free lean percentage, but pigs fed the DDGS diet had reduced ($P < 0.05$) loin eye area compared with pigs fed the control diet. Barrows had greater ($P < 0.05$) live weight, hot carcass weight, and backfat thickness, but less ($P < 0.05$) fat free lean percentage, than gilts. There were no effects of diet on muscle color, marbling, firmness, 24-h loin pH, 48-h drip loss, or loin color, but gilts had less ($P < 0.05$) marbling and 24-h loin pH than barrows. Dietary treatments had no effects on a^* and b^* values of backfat, but pigs fed the control diet had greater ($P < 0.05$) L^* values than pigs fed the DDGS containing diets and gilts had greater ($P < 0.05$) a^* and b^* values than barrows. There were no effects of diet on belly length, belly width, or belly weight, but barrows had heavier ($P < 0.05$) bellies than gilts. Pigs fed the control diet had a greater ($P < 0.05$) flop distance of the belly than pigs fed the DDGS containing diets, but there were no differences among pigs fed the DDGS-containing diets. Barrows also had greater ($P < 0.05$) belly flop distances than gilts. In conclusion, negative effects of DDGS on pork fat quality were not ameliorated by supplementing DDGS containing diets with corn germ, tallow, palm kernel oil, or glycerol.

Key Words: distillers dried grains with solubles, fat quality, pigs

160 Dry fractionation creates highly digestible fractions of wheat DDGS for grower pigs. J. Yáñez^{1,2}, E. Beltranena³, J. Hernández³, and R. T. Zijlstra¹, ¹University of Alberta, Edmonton, AB, Canada, ²Universidad Autónoma de Tlaxcala, Tlaxcala, México, ³Alberta Agriculture and Rural Development, Edmonton, AB, Canada.

Pilot-scale dry fractionation of wheat DDGS by particle size and weight yielded fractions differing in CP and fiber content that would be better suited for feeding young pigs and sows, respectively. The CP content of DDGS stock and fractions FA, FB, FC was 38.5, 48.5, 35.0, and 29.3%. The total dietary fiber of DDGS stock and FA, FB, FC was 29.4, 17.6, 31.8, and 37.4%. To determine their digestible energy and nutrient profile, 6 ileal-cannulated barrows (28 kg) were fed 6 diets at $2.8 \times$ maintenance DE over 6 periods in a 6×6 Latin square. The cornstarch-based diets contained 40% DDGS, 30% FA, 30% FB+10% SBM, 30% FC+15% SBM, 35% SBM and N-free with TiO₂ as indigestible marker. In 9-d periods, feces and digesta were collected for 2 d each. The AID of energy was highest ($P < 0.05$) for diet FA (84.4%), followed for diets FB (80.2), FC (77.7), and DDGS (76.9), and was lowest ($P < 0.05$) for diet SBM (76.1%). The ATTD of energy was highest ($P < 0.05$) for diet SBM (92.5%), then diet FA (90.3), intermediate for diet FB (87.3), and lowest ($P < 0.05$) for diets DDGS (83.8) and FC (83.3%). The DE content was highest ($P < 0.05$) for diets FA (3.91 Mcal/kg) and SBM (3.88), intermediate for diet FB (3.79), and lowest ($P < 0.05$) for diets FC (3.65) and DDGS (3.65 Mcal/kg). The ATTD of GE for ingredients was highest ($P < 0.05$) for SBM (85.4%), intermediate for FA (76.2), that was similar as FB (72.8), then DDGS

(68.7), and lowest in FD (64.9%), that was similar as DDGS. The DE content of SBM (3.97 Mcal/kg) and FA (3.86) were highest ($P < 0.05$), intermediate for FB (3.71), and lowest for DDGS (3.47) and FD (3.23 Mcal/kg). Using a preplanned contrast, reduced fiber content in fractions linearly increased ($P < 0.01$) their ATTD of GE and DE content. Dry fractionation could be a low-cost, environmentally-friendly, plant back-end process that adds value to DDGS by creating fractions for unique stages of swine production.

Key Words: digestibility, fraction, pig, wheat DDGS

161 Feeding increasing canola meal levels with wheat distillers dried grains with solubles to grower-finisher pigs. R. Seneviratne^{1,3}, M. Young², G. Lanz², N. Campbell², R. Zijlstra³, and E. Beltranena^{1,3}, ¹Alberta Agriculture and Rural Development, Edmonton, AB, Canada, ²Gowans Feed Consulting, Wainwright, AB, Canada, ³University of Alberta, Edmonton, AB, Canada.

The effect of feeding increasing levels of solvent-extracted canola meal in diets containing relatively high content of wheat distillers dried grains with solubles (DDGS) on growth performance and carcass traits was evaluated in a commercial-scale study. In total, 550 barrows and 550 gilts (30 kg BW) housed in 50 pens (22 barrows or gilts) were fed 5 dietary regimens over 4 growth phases (d 0 to 21, 22 to 43, 44 to 68, and 69 to 90). Canola meal (0, 6, 12, 18 or 24%) replaced field pea and soybean meal in diets with 15% wheat DDGS formulated to equal NE (2.3 Mcal/kg) and standardized ileal digestible (SID) lysine content (0.94, 0.84, 0.76, 0.67 and 0.62%). In all phases, dietary CP and crude fiber content increased 1.5 and 0.30%, respectively, per each 6% increase in canola meal inclusion. Increasing dietary canola meal inclusion reduced (linear $P < 0.04$) ADFI by 19 g for every 6% increase in canola meal inclusion. Increasing dietary canola meal inclusion in diets reduced (linear $P < 0.01$) ADG by only 7 g for every 6% increase in canola meal inclusion. Increasing the level of canola meal inclusion in diets did not affect G:F ($P > 0.05$). Pigs fed 24% canola meal attained slaughter weight 3 d later ($P < 0.05$) than pigs fed 0% canola meal. Increasing dietary canola meal inclusion in diets containing 15% wheat DDGS did not affect warm carcass weight, dressing percentage, backfat thickness, loin depth, estimated lean yield, or index. In conclusion, increasing the dietary inclusion of solvent-extracted canola meal from 0 to 24% in growout pig diets containing 15% wheat DDGS had only a minor effect on overall growth performance and did not affect carcass traits. Therefore, these high fiber protein meals can be fed together at relatively high levels to grower-finisher pigs as long as diets are formulated on NE and SID AA basis.

Key Words: canola meal, carcass traits, pig performance, wheat DDGS

162 Increasing inclusion of wheat distillers dried grains with solubles (DDGS) in diets for grower finisher pigs: Growth performance, carcass traits, dissected pork yield, loin and belly quality. M. Oryschak¹, J. Aalhus^{2,4}, M. Dugan², M. Young³, N. Campbell³, R. Zijlstra⁴, and E. Beltranena^{1,4}, ¹Alberta Agriculture and Rural Development, Edmonton, AB, Canada, ²Agriculture and Agri-Food Canada, Lacombe, AB, Canada, ³Gowans Feed Consulting Ltd., Wainwright, AB, Canada, ⁴University of Alberta, Edmonton, AB, Canada.

Compared with corn DDGS, little information is available regarding how wheat DDGS affects pig growth performance, carcass traits, pork yield and quality. In a commercial-scale study, 550 barrows and 550

gilts were fed increasing levels of DDGS (0, 7.5, 15, 22.5, 30%) in diets fed over 5 phases from 30 to 118 kg BW. Each gender by dietary regimen combination was replicated in 5 pens of 22 pigs. Phase diets provided 4.0, 3.7, 3.3, 3.0, 2.8 g SID Lys/Mcal NE and the estimated NE value of wheat DDGS used was 2.4 Mcal/kg. Pen BW and feed disappearance were measured. The ADG, ADFI, and G:F for d 0 to 75 was not affected by DDGS level. A subsample of carcasses, 6 barrows and 6 gilts per dietary regimen, was dissected. For each 7.5% increase in DDGS inclusion, the following linear relationships were observed. Warm carcass wt and dressing % tended to decrease ($P < 0.07$) 265 g and 0.3%-units, respectively. Fat hardness decreased ($P < 0.01$) 3.8 durometer units. Yield of bellies decreased ($P = 0.03$) 0.2%-units. Intermuscular fat in picnic and loin decreased ($P < 0.03$) 2.9 and 2.7 g/kg, respectively. Moisture increased ($P < 0.01$) 2 mg/g while fat decreased ($P = 0.05$) 2 mg/g in loin chops. Concentration of MUFA in loin and SFA in bellies decreased ($P < 0.01$) 12 and 6 mg/g, respectively, while PUFA concentration and iodine value in loins and bellies increased ($P < 0.01$) between 11 and 15 mg/g and 1.1 and 1.5 units, respectively. Dissected lean yield of butt, hock, picnic, and loin were not affected by DDGS inclusion level. In conclusion, diets containing up to 30% wheat DDGS and formulated to equal NE and SID Lys resulted in similar growth performance and lean deposition. Reduced fat content in primal cuts suggests the NE value used for wheat DDGS was slightly overestimated.

Key Words: carcass traits, pig performance, pork yield and quality, wheat DDGS

163 Amino acid digestibility and energy content of copra expellers, palm kernel expellers, palm kernel meal, and soybean meal fed to growing pigs. R. C. Sulabo,* W. S. Ju, and H. H. Stein, *University of Illinois, Urbana.*

Two experiments were conducted to determine the apparent (AID) and standardized (SID) ileal digestibility of AA (Exp. 1) and the concentration of DE and ME (Exp. 2) in copra expellers (CE), Asian palm kernel expellers from Indonesia (PKE-IN), African palm kernel expellers from Costa Rica (PKE-CR), African palm kernel meal from Costa Rica (PKM), and in soybean meal (SBM). In Exp. 1, 6 barrows (BW: 34 ± 1.4 kg) were randomly allotted to a 6×6 Latin square design with 6 diets and 6 periods. Five diets contained CE, PKE-IN, PKE-CR, PKM, or SBM as the sole source of AA. A N-free diet was used to calculate endogenous losses of AA and protein. Soybean meal had greater ($P < 0.05$) SID of CP and all indispensable AA than CE, PKE-IN, and PKM. The SID of CP and all indispensable AA except Leu, Met, Phe, Trp, and Val was also greater ($P < 0.05$) in SBM than in PKE-CR. The SID of CP and most indispensable AA in CE, PKE-IN, and PKE-CR were not different, but the SID of Arg, Ile, Leu, Lys, Met, Phe, and Val was less ($P < 0.05$) in PKM than in PKE-CR, but not different from the values obtained for CE and PKE-IN. In Exp. 2, 48 barrows (BW: 35 ± 3.0 kg) were housed individually in metabolism cages and allotted to a randomized complete block design with 6 diets and 8 replicate pigs per diet. A corn-based basal diet and 5 diets containing 70% of the basal diet and 30% of CE, PKE-IN, PKE-CR, PKM, or SBM were formulated. Soybean meal had greater ($P < 0.05$) ATTD of energy (91.2 vs. 87.2, 83.2, 81.5, and 81.6%) and a greater concentration of DE (4,612 vs. 4,013, 3,628, 3,316, and 3,232 kcal/kg DM) and ME (4,380 vs. 3,804, 3,488, 3,199, and 3,092 kcal/kg DM) than CE, PKE-IN, PKE-CR, and PKM, respectively. Copra expellers also had greater ($P < 0.05$) ATTD of energy and DE than all 3 sources of PKM and greater ($P < 0.05$) ME than PKE-CR and PKM. The ME in PKE-IN and PKE-CR was also greater ($P < 0.05$) than the ME in

PKM. In summary, the digestibility of AA and energy is less in copra and palm kernel ingredients than in SBM.

Key Words: amino acids, alternative feedstuffs, energy, pigs

164 Phosphorus and amino acid digestibility in fermented and conventional soybean meal fed to weanling pigs. O. J. Rojas* and H. H. Stein, *University of Illinois, Urbana.*

Two experiments were conducted to measure the apparent AA and P digestibility in US-produced fermented soybean meal (FSBM) fed to weanling pigs. In Exp 1, 30 barrows (initial BW: 14.0 ± 2.28 kg) were allotted to randomized complete block design with 5 diets and 6 pigs per diet. Four diets were formulated to contain FSBM or conventional soybean meal (SBM-CV) and either 0 or 500 units/kg of microbial phytase (Optiphos 2000, Enzyvia, Sheridan, IN). The only sources of P in these diets were FSBM and SBM-CV. A P-free diet that was used to estimate basal endogenous losses of P was also formulated. Feces were collected for 5 d after a 5 d adaptation period. The standardized total tract digestibility (STTD) of P increased ($P < 0.001$) from 65.5 to 71.9% and from 46.1 to 71.4% in pigs fed FSBM and SBM-CV, respectively, when phytase was added to the diets. The STTD of P was also greater ($P < 0.001$) in FSBM than in SBM-CV if no phytase was used, but that was not the case if phytase was added to the diet (soybean meal \times phytase interaction; $P < 0.001$). In Exp 2, 8 barrows (initial BW: 10.4 ± 0.47 kg) were equipped with a T-cannula in the distal ileum and randomly allotted to a replicated 4×4 Latin square with 4 diets and 4 periods per square. Three cornstarch-based diets were formulated with FSBM, SBM-CV, or fish meal as the only source of AA in each diet. An N-free diet that was used to estimate basal endogenous losses of CP and AA was also formulated. Each experimental period lasted 7 d and ileal digesta were collected on d 6 and 7. The standardized ileal digestibility (SID) of all indispensable AA except Lys, Thr, and Trp was greater ($P < 0.001$) in FSBM than in fish meal. The SID of Met and Val were also greater ($P < 0.05$) in FSBM than in SBM-CV, but for the remaining indispensable AA, no differences between FSBM and SBM-CV were observed. In conclusion, the STTD of P in FSBM is greater than in SBM-CV, but the SID of most AA is not different between the 2 ingredients.

Key Words: AA digestibility, fermented soybean meal, p digestibility, soybean meal

165 Nutritional value of co-products for ileal-cannulated grower pigs. J. Yáñez*^{1,3}, E. Beltranena², and R. T. Zijlstra¹, ¹University of Alberta, Edmonton, AB, Canada, ²Alberta Agriculture and Rural Development, Edmonton, AB, Canada, ³Universidad Autónoma de Tlaxcala, Tlaxcala, México.

Description of the digestible nutrient profile of new feedstuffs such as co-products derived from ethanol or oil industries is required before inclusion in swine feeding programs. Nutrient digestibility of 6 co-products was studied in a 7×7 Latin square using 7 diets: wheat mill-run (WM), wheat DDGS plant L (WDDGS-L), wheat DDGS plant T (WDDGS-T), ExtraPro (EP), canola meal (CM), expeller pressed canola meal (EPCM), and N-free. The chemical composition of co-products ranged from 4.18 to 5.16 Mcal/kg GE; 15.4 to 40.2% CP, 2.2 to 6.6% Lys as % of CP, and 82.7 to 91.4% Lys availability. Diets contained 60% (WM and WDDGS-L) and 40% (rest) co-products as the sole source of AA. The N-free diet served to subtract basal endogenous AA losses and as a control for energy digestibility. Seven ileal-cannu-

lated barrows (35.2 ± 0.6 kg BW) were fed 7 diets at 2.8 × maintenance for DE in 7 9-d periods. Feces and ileal digesta were collected for 2 d each. The apparent total tract digestibility (ATTD) of GE and DE content was highest ($P < 0.01$) for EPCM and lowest ($P < 0.01$) for WDDGS-T (Table 1). The standardized ileal digestibility (SID) of all AA was highest ($P < 0.01$) for EPCM and CM. The SID was lowest ($P < 0.01$) for Lys for WDDGS-T, and for Thr and Met for EP. These results indicate that chemical composition and nutrient digestibility vary substantially among co-products. This variability can limit the inclusion level of co-products in grower diets for pigs.

Table 1. Digestibility of GE and AA of co-products in cannulated grower pigs

Item	WM	WDDGS-		EP	CM	EPCM	SEM ¹
		T	L				
ATTD GE, %	66.9 ^d	64.6 ^e	70.6 ^c	73.0 ^b	69.0 ^c	75.6 ^a	0.71
DE, MCal/kg	3.48 ^d	2.96 ^f	3.61 ^c	3.75 ^b	3.31 ^e	4.18 ^a	0.04
SID Lys, %	78.8 ^{bc}	60.3 ^e	71.0 ^d	76.2 ^c	81.9 ^{ab}	85.8 ^a	1.81
SID Thr, %	76.9 ^c	69.8 ^c	74.7 ^{bc}	57.1 ^d	78.2 ^{ab}	81.8 ^a	1.98
SID Met, %	84.3 ^b	69.0 ^c	82.1 ^b	61.9 ^d	88.4 ^a	89.6 ^a	1.20

¹Means within a row without a common superscript differ ($P < 0.01$).

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

166 Digestibility of AA in canola-, cotton-, and sunflower-products fed to finishing pigs. J. C. Gonzalez* and H. H. Stein, *University of Illinois, Urbana*.

The objective of this experiment was to determine the standardized ileal digestibility (SID) of CP and AA in canola-, cotton-, and sunflower-products fed to finishing pigs and to compare these values to

the AID and SID of AA in soybean meal (SBM). Eight pigs (average initial BW: 106.6 ± 5.5 kg) that were fitted with a T-cannula in the distal ileum were used in the experiment. Pigs were allotted to an 8 × 8 Latin square design with 8 diets and 8 periods. Seven ingredients were used: canola seeds (CS), canola meal (CM), cottonseed meal (CSM), sunflower seeds (SFS), sunflower meal (SFM), dehulled sunflower meal (SFM-DH), and SBM. Seven diets each contained 1 of the ingredients as the sole source of AA. An N-free diet was used to estimate basal endogenous losses of AA. Results indicated that among all ingredients, SBM had the greatest ($P < 0.05$) SID of Lys and CS had the least ($P < 0.05$) SID of Phe, Thr, and Tyr. The SID of all indispensable AA except Trp was less in CS than in SBM and CM had a greater ($P < 0.05$) SID of all indispensable AA except Arg, His, Lys, and Trp compared with CS. However, the SID of all indispensable AA except Arg and Trp were less ($P < 0.05$) in CM than in SBM. The SID of all indispensable AA except Arg and Trp were also less ($P < 0.05$) in CSM than in SBM, and the SID of Met was less ($P < 0.05$) in CSM than in all other ingredients. Among sunflower-products, the SID of His, Leu, Phe, and Thr were less ($P < 0.05$) in SFM-DH than in SFS and SFM, and the SID of Ile, Met, and Val were less ($P < 0.05$) in SFM-DH than in SFS, but for CP, Arg, Lys, and Trp, no differences among SFS, SFM, and SFM-DH were observed. The SID of all indispensable AA except Trp were less ($P < 0.05$) in SFM-DH than in SBM, and the SID of His, Ile, Lys, Thr, and Val in SFM were also less ($P < 0.05$) than in SBM. However, except for Lys, no differences between SBM and SFS were observed. In conclusion, the SID of most AA in CS, CM, CSM, SFM, and SFM-DH is less than in SBM.

Key Words: canola, cotten seed meal, soybean meal, sunflower

Nonruminant Nutrition: Amino Acids

167 Determination of the SID lysine requirement of the 7 to 12 kilogram pig under commercial conditions. J. Matthews*¹, C. Neill¹, L. Greiner², N. Williams¹, G. Allee³, J. Connor², S. Jungst¹, and A. Sosnicki¹, ¹PIC North America, Hendersonville, TN, ²Innovation Swine Solutions, LLC, Carthage, IL, ³PorkTech, LLC, Columbia, MO.

A total of 2934 pigs were used to determine the standardized ileal digestible (SID) lysine requirement of the 6.8 to 11.3 kg pig in a commercial testing facility. Pigs were allocated to a 5 × 3 × 2 arrangement of treatments. The treatments included 5 levels of SID lysine (1.20, 1.30, 1.40, 1.50, and 1.60%), 3 sire lines (PIC North America, Hendersonville, TN), and 2 genders (barrows and gilts). Each lysine by sire line combination was replicated with 9 pen replicates of 21 or 22 pigs per pen. Each of these 9 pen replicates consisted of 5 barrow and 4 gilt pens. Average initial and final body weights were 6.9 and 12.2 kg, respectively. Diet analysis revealed SID lysine levels of 1.14, 1.21, 1.31, 1.46, and 1.53%. Differences were observed between the 3 sire-lines, but no sire line by SID lysine level interactions were observed for any of the traits measured. Thus, the SID lysine requirement was considered to be the same between the 3 sire lines and the SID lysine requirement estimate in this research will be based on the overall average performance of the 3 sire lines. As the level of SID lysine was increased in the diet, ADG (linear, $P < 0.001$) and gain:feed (linear, P

< 0.0001 ; quadratic, $P < 0.03$) were increased; however, feed intake was not affected ($P > 0.05$). The SID lysine intake (g/d) and SID lysine efficiency (g lysine/g gain) were both increased as the level of SID lysine was increased (linear, $P < 0.0001$). The SID lysine requirement for ADG was determined to be 1.52% SID lysine using a single-sloped broken line regression model. Gilts had a higher ADG, ADFI, gain:feed, SID lysine intake and SID lysine efficiency ($P < 0.005$). In conclusion, data collected on these 3 sirelines under commercial conditions indicate the experimental pigs had the same SID lysine requirement and this requirement was determined to be 1.52% SID lysine to maximize ADG.

Key Words: sire, pig, lysine requirement, growth

168 Determination of Lys and Trp requirements in 10 to 20 kg pigs. G. I. Petersen* and H. H. Stein, *University of Illinois, Urbana*.

Three experiments were conducted to determine the Lys requirement of 10 to 20 kg pigs (Genetiporc, Alexandria, MN). In experiment 1, 5 corn-soybean meal diets containing between 1.0 and 1.4% standardized ileal digestible (SID) Lys were formulated. All diets were similar with the exception that graded levels of crystalline Lys were used. Data for

ADG and G:F were subjected to a broken line analysis and a quadratic analysis. The resulting SID Lys requirements for ADG and G:F were 1.18 and 1.29% for broken line analysis and 1.28 and 1.39% for quadratic analysis, respectively. A growth assay (Exp. 2) was conducted to develop diets using corn gluten meal (CGM) and field peas or high protein distillers dried grains (HP-DDG) as the main protein sources in corn-based diets. A corn-soybean meal control diet (1.20% SID Lys), 2 corn-CGM-field pea diets (1.20 and 1.35% SID Lys, respectively), and 2 corn-HP-DDG diets (1.20 and 1.35% SID Lys, respectively) were formulated. Pigs fed the control diet had greater ($P < 0.05$) ADG and G:F than pigs fed diets containing corn co-products. Pigs fed the corn-CGM-field pea diet and the corn-HP-DDG diet containing 1.35% SID Lys had greater ($P < 0.05$) G:F than pigs fed the diets with 1.20% SID Lys. Pigs fed the corn-CGM-field pea diet with 1.35% SID Lys also had greater ($P < 0.05$) ADG than pigs fed the same diet with 1.20% SID Lys. In Exp. 3, the requirements for Lys and Trp were determined in pigs fed diets containing corn, CGM, and field peas. Break point and quadratic analyses were conducted for ADG, G:F and plasma urea nitrogen (PUN). The requirements for SID Lys and SID Trp for maximum ADG, G:F, and PUN were 1.07 and 0.19%, 1.11 and 0.18%, and 1.10 and 0.20%, respectively, if the breakpoint analysis was used and 1.22 and 0.25%, 1.34 and 0.22%, and 1.30 and 0.25%, respectively, if the quadratic analysis was used. These data demonstrate that requirement estimates for Lys are influenced by the type of diet that is used and requirement estimates for both Lys and Trp are influenced by the response criteria and the type of analysis that is used to determine the requirement.

Key Words: amino acids, lysine, pigs, tryptophan

169 Effects of standardized ileal digestible (SID) tryptophan:lysine ratio in diets containing 30% dried distiller grains with soluble (DDGS) on finishing pig performance and carcass traits. J. A. Barnes,* M. D. Tokach, J. M. DeRouche, R. D. Goodband, S. S. Dritz, and J. L. Nelssen, *Kansas State University, Manhattan.*

The effects of SID Trp:Lys ratio in growing-finishing pig diets containing 30% DDGS were evaluated in 2 experiments. Within each experiment, crystalline Lys and Trp replaced soybean meal to alter the dietary SID Trp:Lys levels while maintaining minimum ratios of other AA. In Exp. 1, 638 pigs (36.3 kg BW) were used in a 105-d trial (6 pens/trt). Pens of pigs were randomly allotted to 1 of 4 dietary treatments with SID Trp:Lys ratios of 14.0, 15.0, 16.5, and 18.0%. From d 0 to 42, there was a tendency for increased ADG (0.78, 0.83, 0.88, 0.88 kg/d; quadratic $P < 0.06$) and ADFI (1.79, 2.01, 2.04, 2.07 kg/d; quadratic $P < 0.07$) with no changes in G:F as Trp:Lys ratio increased. Overall, ADG (0.79, 0.82, 0.86, 0.90 kg/d) and ADFI (5.22, 5.66, 5.87, 6.06 kg/d) increased linearly ($P < 0.001$) as Trp:Lys increased through 18% with no changes in G:F. As SID Trp:Lys ratio increased, final BW (117.3, 120.4, 125.0, 129.7 kg; linear, $P < 0.01$) and HCW (87.0, 88.7, 93.4, 95.1 kg; linear, $P < 0.01$) increased. The results indicated the optimal SID Trp:Lys ratio was 16.5% from 36.3 to 72.6 kg, but at least 18% from 72.6 to 120.2 kg. In Exp. 2, 1,214 pigs (66.3 kg BW) were used in a 73-d finishing trial (9 pens/trt). Pens of pigs were randomly allotted to 1 of 5 dietary treatments with SID Trp:Lys ratios of 15.0, 16.5, 18.0 and 19.5, and the 15.0% trp:lys diet with L-Trp added to achieve 18.0% SID Trp:Lys. Overall (d 0 to 73), ADG (0.73, 0.76, 0.79, 0.81 kg/d), ADFI (2.42, 2.43, 2.51, 2.53 kg/d), G:F (0.30, 0.31, 0.32, 0.32), final BW (118.2, 120.0, 122.7, 123.8 kg), and HCW (88.4, 89.8, 90.6, 93.0) improved (linear, $P < 0.03$) as dietary SID Trp:Lys increased through 19.5%. Overall, there were no differences between the diet with 18.0% SID Trp:Lys and the diet with 15.0% SID trp:lys

with added L-Trp to 18.0%. These results indicate a SID Trp:Lys requirement of 16.5% up to 72.6 kg and at least 19.5% in late finishing pigs for optimal growth performance in diets containing 30% DDGS.

Key Words: tryptophan, DDGS, finishing pigs

170 Determination of standardized ileal digestible (SID) valine and isoleucine requirements in corn and soybean meal (C-SBM) diets for 20- to 50-kg pigs. A. M. Waguespack*¹, T. D. Bidner¹, R. L. Payne², and L. L. Southern¹, ¹Louisiana State University, Agricultural Center, Baton Rouge, ²Evonik-Degussa Corp., Kennesaw, GA.

Three experiments were conducted to determine the SID Val and Ile requirements for 20- to 50-kg pigs fed C-SBM-based diets. In all experiments (26 to 27 d), diets contained 0.83% SID Lys, which is the determined Lys requirement of the pigs used. All diets were supplemented with 0.335% L-Lys, 0.14% DL-Met, 0.19% L-Thr, 0.05% L-Trp, 0.53% Gly, and 1.03% L-Glu to meet ratios of SID AA:SID Lys of 0.62 TSSA, 0.71 Thr, and 0.20 Trp and to achieve 1.66% Gly+Ser and 3.284% Glu. Treatments were replicated with a minimum of 5 pens with 3 to 4 pigs each in randomized complete block designs. In Exp. 1, all diets contained 0.065% L-Ile to maintain 0.498% SID Ile (0.60 SID Ile:Lys). L-Val was added to the diets at 0.02% increments from 0 to 0.10% to achieve 0.51 to 0.61% SID Val. Valine addition increased ADG (720, 776, 784, 814, 829, and 803 g), ADFI (1,788, 1,956, 1,903, 1,949, 2,011, and 1,908 g), and G:F (0.40, 0.40, 0.41, 0.42, 0.42, 0.42 g/g) in pigs fed 0.51 to 0.59% SID Val (linear, $P < 0.08$), but ADG, ADFI, and plasma urea nitrogen (6.91, 7.49, 7.47, 7.69, 7.94, and 6.70 mg/dL) were decreased at 0.61% SID Val (quadratic, $P < 0.10$). The SID Val requirement was estimated to be between 0.56 and 0.58% using ADG and G:F, or Val:Lys of 0.67 and 0.70. In Exp. 2 and 3, diets contained 0.61% SID Val and L-Ile was added at 0.02% increments from 0 to 0.08% to achieve 0.43 to 0.51% SID Ile. In Exp. 2, Ile addition increased ADG (792, 747, 766, 807, and 799 g) from 0.45 to 0.49% SID Ile (linear, $P < 0.06$), but plateaued at 0.51% SID Ile (quadratic, $P < 0.06$). Daily feed intake (1,999, 1,883, 1,914, 2,027, and 1,929 g) was not affected ($P > 0.10$) by Ile addition to the diet. Isoleucine addition tended to increase G:F (0.397, 0.399, 0.401, 0.399, and 0.415 g/g) in pigs fed 0.43 to 0.51% SID Ile (linear, $P < 0.11$). In Exp. 3, ADG, ADFI, and G:F were not affected by Ile addition to the diet. The results of this research indicate that the SID Val requirement is between 0.56 to 0.58% (0.67 to 0.70 SID Val:SID Lys), and the Ile requirement is adequate at 0.43% SID Ile (0.52 SID Ile:SID Lys) for 20- to 50-kg pigs.

Key Words: pigs, valine, isoleucine

171 Impact of varying dietary lysine and sulfur amino acids on growth performance of 10 to 20 kg pigs. J. K. Htoo*¹ and J. Morales², ¹Evonik Degussa GmbH, Hanau-Wolfgang, Germany, ²PigChampPro Europa, S. A., Segovia, Spain.

Lysine requirement of today's high lean pigs may be higher than currently assumed. Methionine is considered the second or third limiting amino acid (AA) in typical swine diets. A 21-d growth assay was conducted with 324 PIC pigs [GP1050; initial body weight (BW) = 9.6 kg] to estimate the optimal standardized ileal digestible (SID) sulfur amino acids (SAA):Lys ratio for 10 to 20 kg pigs. Pigs were blocked by BW and allotted to 9 dietary treatments with 6 pigs (3 barrows and 3 gilts) per pen and 6 replicates per treatment. Diets 1 to 4 and 9 were formulated to contain SID SAA of 0.55, 0.63, 0.71, 0.78, 0.86%,

respectively and identical SID Lys of 1.38% by adding DL-Met. Diets 5 to 9 contained SID Lys of 0.98, 1.08, 1.18, 1.28, 1.38%, respectively and identical SID SAA of 0.86% by adding L-Lysine HCl. Diets used were formulated to be isocaloric (2510 kcal/kg NE) and contained corn, soybean meal, wheat, whey powder, fishmeal and soybean oil. Contents of all other AA were similar in all diets. Individual BW and per pen feed disappearance were recorded weekly to calculate ADG, ADFI, and FCR. The overall ADG and FCR improved linearly ($P < 0.001$) as the SID Lys level increased. The ADFI was not affected ($P > 0.05$) by treatments. Using ADG and FCR as response criteria, the SID Lys requirement was estimated to be slightly higher than 1.38% by exponential regression (95% of asymptotic response). As the SID Lys requirement was still higher than the highest tested level of 1.38%, SAA was first limiting and Lys was second limiting in the test diets 5 to 9, which allowed for estimation of the optimal SAA:Lys. During the 21-d period, the ADG and FCR improved linearly ($P < 0.05$) as the SAA:Lys ratio increased. The ADFI was not affected ($P > 0.05$) by the SAA:Lys ratios. The dietary SID SAA:Lys to maximize ADG was 59% based on exponential regression. To minimize the FCR, a dietary SID SAA:Lys of at least 62% is required. On average, the optimal SID SAA:Lys ratio was estimated to be approximately 60% in 10 to 20 kg PIC pigs.

Key Words: lysine, methionine, pigs, sulfur amino acids

172 The amino acid requirements of finisher pigs are higher for entire male than for female pigs between 50 and 100 kg live weight.

K. L. Moore¹, B. P. Mullan^{*1}, and R. G. Campbell², ¹Department of Agriculture and Food Western Australia, Perth, Western Australia, Australia, ²Pork Co-Operative Research Centre, Willaston, South Australia, Australia.

To minimize the cost of production and to optimise the genetic potential of our animals it is essential that we measure the amino acid requirement of finisher pigs on a regular basis and then feed accordingly. It has been at least 10 years since the lysine requirement for finisher pigs in Australia was determined, and so the aim of this experiment was to determine the optimal level of available lysine/MJ digestible energy (Av Lys/MJ DE) for the PIC genotype from 50 to 100 kg live weight (LW). Four hundred and 20 pigs (Large White x Landrace x Duroc) were used in a 2 × 5 factorial experiment, with the treatments being sex (entire males, M and females, F) and available lysine (0.4, 0.5, 0.6, 0.7 and 0.8 g Av Lys/MJ DE). The diets were formulated to contain 13.5 MJ DE/kg and were based on the ideal pattern of amino acids. Pigs were in groups of 7 and fed ad libitum. To estimate lysine requirements a spline model was fitted to the data, with requirements estimated at either 95% for average daily gain (ADG) or 105% for feed to gain of the high-lysine plateau. The lysine requirement for ADG was 0.60 g Av Lys/MJ DE for both M and F, while the lysine requirement for optimal feed to gain was 0.70 and 0.66 g Av Lys/MJ DE for M and F, respectively. The overall performance of pigs on this experiment was excellent by industry standards (Table 1). The calculated requirements for finisher pigs to maximise performance were higher for M than for F, and most likely higher in general than those currently used by industry.

Table 1. Average daily gain (ADG), feed to gain (F:G) and depth of backfat (P2) for entire male (M) and female (F) pigs fed varying levels of Av Lys/MJ DE from 50 to 103 kg LW (n=6)

Av Lys/MJ DE	0.4	0.5	0.6	0.7	0.8	SED
M - ADG (g)	949	1056	1086	1066	1069	24.9
F - ADG (g)	879	952	988	966	931	
M - F:G	2.41	2.21	2.22	2.14	2.17	0.043
F - F:G	2.57	2.53	2.46	2.41	2.56	
M - P2 (mm)	12.3	12.5	12.5	11.1	11.8	0.468
F - P2 (mm)	12.8	12.4	12.5	12.7	12.2	

Key Words: pigs, lysine, growing pigs, sex

173 The evaluation of lysine requirements in third parity lactating sow diets.

L. Greiner^{*1}, J. Usry², C. Neill³, N. Williams³, J. Soto¹, J. Connor¹, and G. Allee^{4,1}, ¹Innovative Swine Solutions, LLC, Carthage, IL, ²Ajinomoto Heartland, LLC, Chicago, IL, ³PIC, Hendersonville, TN, ⁴PorkTech, LLC, Columbia, MO.

An experiment using 306 third parity sows was conducted to evaluate the effect of SID lysine on lactation performance. Sows (PIC, Camborough 29, 240.5 ± 47.7 kg) were randomly assigned to one of 5 experimental diets containing different levels of SID lysine. Typical corn and soybean meal (48%) diets with increasing levels of soybean meal were used to achieve the dietary treatments (SID lysine levels of 0.67, 0.81, 0.95, 1.09, and 1.23%, respectively). No crystalline amino acids were added to diets and all diets were formulated to have 3.45 Mcal ME/kg and contained vitamins and minerals that exceeded recommendations (NRC, 1998). Sows were fed a maximum of 5.6 kg per day from d 3 post-parturition to weaning resulting in an average grams of SID lysine per day of 35.4, 43.7, 51.5, 58.6, and 65.2, respectively. Increasing SID lysine (from 0.67 to 1.23%) resulted in a linear reduction in wean to first breed (7.69, 5.51, 5.88, 6.00, 4.01 d, $P < 0.01$). In addition, the increasing levels of lysine also reduced the percent of sow body weight loss (-7.72, -4.65, -4.30, -2.37, -5.18, quadratic $P < 0.01$). The average litter gain was 2.71, 2.74, 2.81, 2.83, and 2.99 kg/d (linear, $P < 0.01$) when sows were fed 35.4, 43.7, 51.5, 58.6, and 65.2 g of SID lysine per day, respectively. There was also a linear ($P < 0.01$) increase in pigs weaned as the SID lysine level increased. In addition, there were no differences in subsequent total born when SID lysine was increased. These data demonstrate that lactation diets for parity 3 females can require high levels of SID lysine to support high litter growth rates and supports previous published data evaluating lysine requirements based on litter growth rates.

Key Words: sow, lactation, lysine

174 The use of crystalline amino acids in lactating sow diets.

L. Greiner^{*1}, J. Usry², C. Neill³, N. Williams³, J. Soto¹, J. Connor¹, and G. Allee^{4,1}, ¹Innovative Swine Solutions, LLC, Carthage, IL, ²Ajinomoto Heartland, LLC, Chicago, IL, ³PIC, Hendersonville, TN, ⁴PorkTech, LLC, Columbia, MO.

Five hundred and 45 primiparous and multiparous sows were evaluated to understand the impact of feeding crystalline amino acids on lactation performance. PIC Camborough 29 sows ranging from first parity to third parity were blocked by parity and randomly allotted to one of 5 experimental diets containing different levels of L-lysine.HCl (0.1, 0.2, 0.3, 0.4, and 0.4% + valine, respectively) within parity block, replacing intact lysine, mainly from soybean meal. L-Threonine and

methionine (Alimet) were included in the diets as necessary to maintain the SID Thr:Lys and SID M+C:Lys ratios above 65% and 49%, respectively. In addition, the last treatment with 0.4% crystalline lysine was supplemented with 0.025% valine to increase the SID Val:lys ratio from 64 to 69, respectively. All diets were formulated to have the same SID lysine (1.12%) and 3.45 Mcal ME/kg and contained vitamins and minerals that exceeded recommendations (NRC, 1998). Parity 1 females were allowed a maximum feed intake per day of 5.2 kg, parity 2 females were allowed a maximum feed intake per day of 5.5 kg, and parity 3 females were allowed a maximum feed intake per day of 5.7 kg. Increasing L-lysine.HCl resulted in similar litter and reproductive performance. The average litter gain was 2.70, 2.72, 2.67, 2.71, and 2.64 kg/d ($P < 0.30$) when sows were fed 0.10, 0.20, 0.30, 0.40, and 0.40% L-lysine.HCl plus valine, respectively. Interestingly, the addition of valine did not improve litter growth rate or improve subsequent total born (13.85, 13.98, 13.73, 13.84, and 13.81 pigs respectively, $P < 0.96$) This study demonstrates that corn/soybean meal lactation diets for all parities can contain up to 0.40% L-lysine.HCl with only supplemental threonine and a methionine source and have no detrimental effect on litter growth rate and subsequent total born. The SID Val:Lys ratio does not appear to be greater than 64%.

Key Words: sow, lactation, lysine

175 Drying method does not appear to alter nitrogen or energy concentrations in pig feces and urine, or poultry excreta. B. M. Jacobs^{*1}, J. F. Patience¹, W. A. Dozier², K. J. Stalder¹, and B. J. Kerr³, ¹Iowa State University, Ames, ²Auburn University, Auburn, AL, ³USDA-ARS-NLAE, Ames, IA.

Accurate measurements of digestibility coefficients are critical in nutrient balance and feed evaluation studies as errors that occur are not self-cancelling, but often additive. To date, however, there are no universal methods for drying feces, urine, or excreta before laboratory analysis. The objective of this trial was to evaluate the impact of 4 different drying methods on nutrient concentrations. Twelve individually penned growing pigs were fed 1 of 3 diets and 16 pens of 10 growing broilers were fed 1 of 4 diets that differed in NDF and CP levels from which to obtain feces, urine, and excreta that varied widely in nutrient composition. All samples were dried by 1 of 4 methods: UD-undried, FD-freeze-dried, OD55-oven-dried at 55°C for 48 h, or OD100-oven-dried at 100°C for 48 h, after which DM, GE, N, C, and S were determined. There was no interaction between diet type and drying method noted for either the swine or poultry data. For swine feces, drying resulted in a loss of GE ($P < 0.10$) and S ($P < 0.05$) by 5% and 58%, respectively. There was no difference between drying method on DM, GE, N, C, or S concentrations. There were no differences in urinary GE due to drying or between drying methods, however urinary

DM was highest by FD compared with OD ($P < 0.05$) and higher for OD55 compared with OD100 ($P < 0.01$). For poultry excreta, GE ($P < 0.05$), N ($P < 0.10$), and S ($P < 0.01$) were reduced by drying by 6%, 10%, and 66%, respectively. There was no difference between drying methods except FD excreta had a higher S concentration than OD ($P < 0.10$). Regardless of drying method utilized, some loss of GE and N appears to be inevitable, but there is no apparent advantage between freeze drying and oven drying. The apparent high level of S losses warrants further investigation.

Key Words: drying methods, feces, poultry excreta, swine

56 Dietary tryptophan requirement for growing pigs during high immune stress. R. D. Boyd^{*1}, C. E. Zier-Rush¹, R. Martin², R. Palan¹, and S. Smith¹, ¹The Hanor Company, Franklin, KY, ²Ralco Nutrition, Marshall, MN.

Our estimate of the Tryptophan (TRP) requirement (ideal TRP:LYS ratio) for healthy pigs in the 11–22 kg phase varied from 17.0 (linear-plateau intersect) to 19.9 at asymptote (Fent et al. 2010). The impact of high immune stress on this requirement is unclear, but is suggested to be higher (Le²floch et al. 2007). We studied the TRP requirement under high immune stress using a total of 1199, 20 d old pigs (PIC Camborough x TR-4). Female and castrate pigs were derived from an acutely PRRS affected sow farm. They were PRRS viremic and lethargic at arrival. Strep Suis arose as a secondary infection. Pigs were placed on test at 11.0 ± 0.3 kg b.w. and after pigs had undergone seroconversion (20.4% mortality). Pigs were allotted by sex from weight blocks to 5 diets (104 pens; 11–12 pigs/pen). A positive control (PC) diet served as a LYS adequate reference (1.25% SID LYS, 0.19 TRP:LYS ratio) and a negative control (NC) diet was supplemented with TRP to establish 4 dose response diets (SID LYS 1.10, TRP:LYS: 0.13, 0.16, 0.19, 0.22). Diets were fed for 27 d to an average end weight of 23.1 ± 0.6 kg. Pigs fed the NC (SID LYS 1.10, TRP:LYS 0.13) consumed less feed (0.65 vs 0.78 kg/d), grew slower (0.34 kg/d vs 0.45 kg/d) and were less efficient (0.51 v 0.57 G:F) than pigs fed the PC. The NC diet performed inferior to NC + TRP diets ($P < 0.05$): ADG (0.34 vs 0.44, 0.45, 0.43), G:F (0.51 vs 0.55, 0.56, 0.56). Pigs fed TRP supplemented diets (0.16–0.22 TRP:LYS) grew similar to PC ($P > 0.05$), but were less efficient ($P < 0.05$). The G:F result confirms that the NC LYS level was below requirement and that gain composition was inferior to PC. Total gain and G:F response was regressed on TRP:LYS ratio (0.13–0.22) using a quadratic equation. The TRP:LYS requirement at asymptote was 0.193, and 0.168 at 95% asymptote (near financial optimum). We conclude that the TRP requirement during high immune stress is similar to the requirement in good health. TRP may be more important under high immune stress but not in isolation from other amino acids.

Key Words: pigs, tryptophan, immune stress

Nonruminant Nutrition: Minerals

176 Effect of zinc level and source on pig postweaning growth performance and tissue mineral content. J. S. Jolliff^{*1}, D. C. Mahan¹, G. M. Hill², and J. E. Link², ¹The Ohio State University, Columbus, ²Michigan State University, East Lansing.

Dietary Zn source (organic or inorganic) and level were used to evaluate pig performance and tissue mineral content in a 2 × 4 + 1 factorial, RCB design with 10 replicates (5 pigs per pen) over a 28 d postwean-

ing period (n = 450). Organic Zn was supplied as Zn proteinate (Bio-plex; Alltech, Nicholasville, KY) and inorganic Zn was supplied as Zn sulfate (Akey, Inc., Lewisburg, OH). Supplemental levels of Zn were 25, 50, 75, or 100 mg/kg diet from each source. A basal diet was not fortified with Zn but did contain the other essential minerals. Diets (2 phases) were fed from 0 to 10 and 10 to 28 d postweaning. Pig from each treatment within replicate was killed at 10 and 28 d postweaning

with liver, heart, and kidney collected and weighed (180 total pigs). Diets without supplemental Zn were analyzed to contain 32 (phase 1) and 50 (phase 2) mg/kg innate Zn from the dietary ingredients. ADG increased quadratically ($P < 0.05$) with increasing levels of organic and inorganic Zn over both phases with daily gains peaking at the supplemental level of 75 mg in phase 1 and 50 mg/kg in phase 2. G:F improved with Zn fortification as both organic ($P < 0.05$, quadratic) and inorganic ($P < 0.05$, linear) Zn levels increased for the 0 to 10 d phase but not thereafter. ADFI was not influenced by Zn treatment. Liver weights increased quadratically ($P < 0.05$) with Zn fortification by d 28. As Zn level increased, the Zn concentration ($\mu\text{g}/\text{mg}$) of the liver changed quadratically ($P < 0.05$) on d 10, but increased linearly ($P < 0.05$) on d 28. Total liver Zn content (mg/liver) increased linearly ($P < 0.05$) with Zn level at d 28. There were small but quadratic increases ($P < 0.05$) in total Zn of the heart and kidney as Zn level increased on d 28. There was no effect of Zn source or Zn source \times level interaction on the Zn concentration or content of any tissue analyzed. These results indicate that added Zn is needed at a supplemental level of 50 to 75 mg/kg (total 100 mg/kg including innate Zn) in the complex nursery diets of weanling pigs to meet the pigs' growth requirement.

Key Words: pig, zinc, minerals

177 Organic and inorganic Zn impact on antioxidant enzymes and metallothionein in nursery pigs. G. M. Hill^{*1}, J. E. Link¹, and D. C. Mahan², ¹Michigan State University, E. Lansing, ²The Ohio State University, Columbus.

Zinc is critical for health and performance of nursery pigs because of its role in growth, immune function, and antioxidant activity. The requirement during this developmental stage should be based on metabolic need and not organ retention. To determine Zn need, pigs were weaned at 17 to 19 d of age and fed a 2 phase complex nursery diet in 10 dietary treatments (Trt): basal diet (B), no added Zn; B plus 25, 50, 75 or 100 ppm Zn as Bioplex (ORG) or sulfate (INORG); or B plus 25 ppm Zn from each source. Six pigs were killed at weaning, 6 pigs/Trt at d 10, and 8 pigs/Trt at d 28 to determine activities of hepatic Mn superoxide dismutase (SOD), CuZnSOD, glutathione peroxidase (GSH-Px), and concentrations of hepatic, duodenal, jejunal metallothionein, (Mt) and Zn. The activity of MnSOD was greater ($P < 0.01$) at 10 than 28 d except in pigs fed diet B. GSH-Px activity was greater ($P < 0.04$) at 28 than at 10 d. If dietary minerals were adequate, this may reflect differing needs at the time of measurement. Perhaps due to its role in storage, hepatic Mt was greater than duodenal and jejunal Mt regardless of Zn source and age. Reflective of its role in absorption, duodenal Mt was always greater than jejunal Mt and peaked at 75 ppm similar to hepatic Zn concentration ($P = 0.01$). The greater hepatic Mt concentrations with ORG at 25 and 50 ppm may indicate higher availability when inadequate Zn is provided in the diet. This is validated by greater ($P < 0.05$) duodenal Mt with ORG than INORG. The greater hepatic CuZnSOD activity in pigs fed diet B vs. supplemented diets ($P < 0.03$) may be reflective of increased need or inadequate Zn for SOD synthesis. CuZnSOD activity in pigs fed the combination Trt at 50 ppm was also less ($P < 0.01$) than in the sole source Trts. This research illustrates that Zn from Bioplex may be more effective in providing Zn for biological functions in nursery pigs compared with Zn sulfate and that a minimum of 75 ppm should be added to a complex nursery diet.

Key Words: organic Zn, inorganic Zn, nursery pig

178 Impact of zinc source on grow-finish performance, carcass composition and locomotion score. J. F. Patience^{*1}, A. Chipman¹, T. L. Ward², and M. E. Wilson², ¹Iowa State University, Ames, ²Zinpro Corp., Eden Prairie, MN.

There is considerable interest in the use of organic sources of minerals as compared with the more traditional inorganic sources in swine diets. This experiment was conducted to determine if a zinc amino acid complex (Availa-Zn 100 or AZ) would enhance growth performance, carcass composition and locomotion of growing-finishing swine. A total of 528 pigs were assigned to 48 pens of 11 pigs each, providing 12 pens and 132 pigs per treatment, arranged as a randomized complete block; gender was equalized across treatments. Pigs received feed and water ad libitum. The experiment was divided into 5 phases: 25 to 41 kg, 41 to 66 kg, 66 to 89 kg, 89 to 103 kg and 103 to 126 kg BW, respectively. All diets contained a basal 110 mg Zn/kg as zinc sulfate (ZnS); zinc treatment additions were added on top of this basal amount. Trt A contained 50 ppm extra Zn as ZnS in all diet phases; ractopamine (RAC) was included in phase 5 in a step-up program of 2.5 mg/kg for 2 weeks followed by 7.2 mg/kg. Trt B was similar to A without RAC in phase 5. Trt C was similar to Trt A, except AZ replaced ZnS in phases 1 to 5. Trt D was similar to Trt C, except that AZ replaced ZnS only in phases 3 to 5. Pigs fed Trt C and D grew faster than pigs fed Trt B and pigs fed Trt C also grew faster than the pigs fed Trt A ($P < 0.05$). There were no differences in feed intake among Trt B, C and D, but the pigs receiving Trt C and D ate more feed than the pigs receiving Trt A ($P < 0.05$) suggesting AZ mitigated reduced feed intake associated with RAC. Trt A, C and D pigs had the same feed efficiency but better feed efficiency than Trt B pigs ($P < 0.05$). Locomotion score conducted before marketing the first pigs was best for Trt B pigs ($P < 0.10$). Trt A pigs had the poorest locomotion score ($P < 0.10$); Trt C and D pigs earned intermediate scores. There was no advantage of Zn source for loin depth ($P > 0.05$). We concluded from this experiment that zinc amino acid complex shows promise as a feed additive capable of enhancing the response of pigs to RAC.

Key Words: ractopamine, zinc amino acid complex, swine, locomotion

179 Growth performance and diet preference of nursery pigs fed varying levels of salt. J. S. Monegue,* M. D. Lindemann, H. J. Monegue, and G. L. Cromwell, University of Kentucky, Lexington.

Evaluation of the nutritional impact of added dietary salt is limited. Some research shows that nursery pigs fed diets formulated with ingredients that have a high intrinsic level of salt, such as those containing dried whey, still responded to added salt in the diet. Therefore, a series of experiments were conducted to evaluate the effects of 3 levels of added salt in nursery diets. A total of 288 crossbred barrows and gilts (mean initial BW, 6.67 ± 1.61 kg) were used in 3 performance and 3 preference studies of 4-wk duration. Pigs were allotted to treatments based on sex with barrows and gilts penned separately, initial BW, and breed of sire. Pigs in the performance studies were fed a corn-soybean meal-lactose based diet calculated to contain 0.02% Na and 0.05% Cl to which 0.1, 0.5, or 0.8% salt was added (NRC, 1998 requirement estimate is 0.20% Na and Cl for 5–10 kg pigs and 0.15% Na and Cl for 10–20 kg pigs). For preference studies, 3 comparisons of the same diets were made: 1) 0.1% vs. 0.5%, 2) 0.1% vs. 0.8%, and 3) 0.5% vs. 0.8% salt. Results for the studies were pooled for analysis. In the performance studies, graded salt additions were associated with increased feed intake (570, 628, and 665 g/d, $P = 0.0013$) daily gain (273, 402, and 414 g/d, $P < 0.0001$) and G:F (0.48, 0.64, and 0.62, $P < 0.0001$). When pigs were given a choice between 0.1 and 0.5% added salt they

preferred the diet with 0.5% (62:38, $P = 0.007$). Pigs offered a choice between 0.1 and 0.8% added salt showed similar results preferring the diet with the higher salt level (58:42, $P = 0.04$). There was not a preference when 0.5 and 0.8% added salt were offered (49:51, $P = 0.87$). In the barrow replicates, preference for added salt was stronger than in the gilt replicates. Additionally, preference for salt appeared to diminish after the initial 2 wk in both barrows and gilts. In summary, nursery pigs can differentiate diet differences based on the salt content of the diet and the salt level clearly affects performance in pigs not given a choice; particularly when the diet fed is deficient in Na and Cl.

Key Words: pigs, salt, preference

180 Effect of phosphorus and calcium depletion-repletion periods on the digestive and metabolic utilization of dietary phosphorus and calcium in growing pigs. M. P. Létourneau-Montminy^{*1}, P. A. Lovatto², and C. Pomar¹, ¹Agriculture and Agri-Food Canada, Sherbrooke, QC, Canada, ²University Federal of Santa Maria, Santa Maria, Brazil.

Improving utilization of dietary phosphorus (P) without modifying pig performance could be an efficient strategy to improve production sustainability. The ability of pigs to modify P digestive and metabolic utilization when fed with low-P or control diets was studied using different sequences of dietary P and calcium (Ca) restriction (depletion) and recovery (repletion). Seventy-two pigs were fed according to a 3-phase feeding program (25–50, 50–80 and 80–110 kg BW) with either a control diet (C) which provided the recommended digestible P level or a low-P diet (L) providing 40% less digestible P with a constant Ca/digestible P ratio. The CCC, CCL, CLL, LCC, LLC and LLL sequences were tested. Bone mineral content (BMC, g) was obtained at the lumbar region by dual x-ray absorptiometry at the beginning and at the end of each growing phase. Total faeces and urine collection was performed during the 2nd and 3rd growing phase. BMC was reduced at the end of the 1st growing phase in pigs fed the L compared with C diet (29%, $P < 0.001$). During the 2nd growing phase, BMC retention (g/d) was higher in these pigs (LC and LL) compared with Control pigs (CC and CL, 23%, $P < 0.001$). During the 3rd growing phase, pigs fed LLC diet absorbed 26% more Ca ($P < 0.01$) and retained 53% more BMC ($P < 0.05$) than CCC pigs. Digestive and metabolic adaptations allowed pigs fed with C diets during the last, or during the 2 last feeding phases after 2 (LLC) or 1 (LCC) P depletion periods to reach similar BMC as the control pigs (CCC). Although P excretion was reduced by about 18% in LLC compared with CCC pigs, the practical applications of these results require a better understanding of the degree, the timing and the duration of depletion and repletion periods. Nevertheless, these metabolic adaptations are a promising alternative for improving P efficiency in swine.

Key Words: depletion-repletion, phosphorus, pig

181 The effect of a novel *E Coli* phytase (Quantum™) on the growth performance of nursery pigs. P. Wilcock^{*1}, M. R. Bedford¹, C. L. Walk¹, B. Bass², and C. V. Maxwell², ¹AB Vista, Marlborough, United Kingdom, ²University of Arkansas, Fayetteville.

It is hypothesized that even a low level of dietary phytate is detrimental to piglet performance. This study was designed to determine if high levels of an *E Coli* phytase when added to a simple diet (low animal protein/high soybean meal/high phytate) would improve pig performance and be comparable to pigs fed a complex diet (high animal protein/low soybean meal/low phytate). Weaned pigs ($n = 228$; 20.25 d of age, 6.6 kg) were assigned to one of 6 dietary treatments (8 replicates/treatment): 1) Complex Diet (CD); 2) Simple Diet (SD); 3) SD

+ 1000 FTU/kg; (SD1); 4) SD + 1750 FTU/kg; (SD2) 5) SD + 2500 FTU/kg; (SD3) 6) SD + 3250 FTU/kg; (SD4). All pigs were fed a 3 phase diet program [0–7 d (P1), 7–21 d (P2), 21–35 d (P3)] with each phase across treatments formulated to be iso-nutrient and to meet NRC (1998) available P requirements (P1 = 0.52%, P2 = 0.48%, P3 = 0.42%) not including the P release by phytase. In P1 the CD pigs had a tendency ($P < 0.11$) for improved G:F compared with SD. During P2, pigs fed the CD grew faster ($P < 0.05$), ate more feed ($P < 0.01$), tended to be heavier ($P < 0.10$) and to have poorer G:F ($P < 0.07$) than SD. Overall (d 35) pigs on the CD tended ($P < 0.10$) to have an improved BW, ADG and ADFI when compared with SD. In P2 pigs fed phytase at all levels of addition had an improved ADG ($P < 0.02$) and ADFI ($P < 0.06$) and were heavier ($P < 0.02$) when compared with SD. Combined P1+P2 showed a tendency for improved gain ($P < 0.08$) and G:F ($P < 0.05$) for all levels of phytase addition when compared with SD. At d 35 for all levels of phytase addition, pigs were heavier than SD ($P < 0.03$) and tended to have better ADG ($P < 0.10$) and ADFI ($P < 0.11$). Final BW for the nursery study for CD, SD, SD1, SD2, SD3, SD4 were 24.56, 23.30, 24.91, 24.21, 24.25, 24.85 kg, respectively with all SD plus phytase addition being different ($P < 0.03$) to the SD and not different from CD ($P > 0.90$). In conclusion the addition of an *E Coli* phytase to a SD improved growth in the nursery to a level similar to the CD.

Key Words: pigs, phytase, growth

182 Nutrients changes in fetal and maternal tissues of gilts fed organic selenium during gestation. Y. L. Ma^{*1}, M. D. Lindemann¹, J. M. Unrine¹, J. L. Pierce², and G. L. Cromwell¹, ¹University of Kentucky, Lexington, ²Alltech Inc., Nicholasville KY.

The objective of this study was to characterize nutrient changes in fetal and maternal tissues during gestation. Crossbred gilts ($n = 69$) were selected at 183 ± 2.7 d and 137 ± 10 kg BW and allotted to receive Se (0.3 mg/kg diet) as Na selenite or organic Se (Sel-Plex®; Alltech Inc., Nicholasville KY). Gilts were housed in gestation crates at 267 ± 5.7 d (171 ± 4 kg), estrus-synchronized, and bred. Gilts were then slaughtered at d 0, 43, 58, 73, 91, 101, or 108 of gestation ($n = 6$ to 12 gilts/d). Fetuses were collected for dry matter (DM), nitrogen (N), and ether extract (EE) analysis. Se, Cu, Fe, Mn, and Zn in fetus and maternal liver were analyzed by ICP-MS. With regard to Se source, Se concentrations (DM basis) in fetuses and in liver of gilts fed organic Se were greater ($P < 0.01$) than those fed selenite (fetus 0.95 vs. 0.75 mg/kg and maternal liver 2.57 vs. 2.36 mg/kg). Mn concentrations in maternal liver (6.19 vs. 5.57 mg/kg, $P < 0.01$) and Fe concentration in fetuses (239.3 vs. 226.4 mg/kg, $P = 0.08$) were elevated in response to organic Se. With regard to stage of gestation, fetal DM increased quadratically (10.0, 11.0, 11.4, 13.3, 15.5, 17.2%; $DM = 14.62 - 0.18x + 0.0018x^2$, $r^2 = 0.94$; where $x = d$ of gestation; $P < 0.01$), and EE increased cubically ($P < 0.01$), and N decreased cubically (10.4, 9.42, 9.14, 9.03, 9.02, 9.04%; $n = 115.87 - 1.97x - 0.022x^2 - 0.000079x^3$, $r^2 = 0.61$; $P < 0.01$). For fetus, trace element concentration decreased linearly for Zn ($P < 0.01$), quadratically for Se ($P < 0.01$), and cubically for Cu, Fe, and Mn ($P < 0.01$) during gestation. Total Cu content in fetus increased quadratically (0.00, 0.24, 0.89, 1.20, 1.67, 2.56, 3.11 mg; $P < 0.01$) as did Mn (0, 4, 49, 133, 331, 362, 492 μ g; $P < 0.01$) and Se (0, 2, 12, 33, 77, 111, 162 μ g; $y = 1.99 - 1.00x + 0.019x^2$, $r^2 = 0.94$; $P < 0.01$) whereas Fe content increased cubically (0.0, 0.5, 3.0, 9.6, 24.2, 30.5, 46.6 mg; $P < 0.01$). The results demonstrate the dynamic nutrient deposition that occurs during fetal development in gestation. Organic Se was associated with greater Se accumulation in both maternal and fetal tissue demonstrating clear source differences.

Key Words: gestation, fetal development, selenium

Nonruminant Nutrition: Quantifying Feed Ingredient Quality

183 (Invited) Methodology for valuing quality of feedstuffs. H. H. Stein,* *University of Illinois, Urbana.*

The nutritional value of feed ingredients is usually assessed by using a 3-step procedure. The first step involves a chemical analysis of energy and nutrients in the ingredient. Energy is analyzed as GE and proximate analysis will yield values for CP, ether extract, ash, and moisture. The concentration of carbohydrates is usually calculated by subtracting concentrations of moisture, ash, ether extract, and CP from 100. In cereal grains and in by products of cereal grains, the concentration of starch is usually also analyzed and the concentration of fiber can then be calculated by subtracting the amount of starch from the total amount of carbohydrates in the ingredient. If the ingredient contains more than a few percent CP, an analysis for the concentration of AA is also required and the concentrations of Ca and P are usually also analyzed. The second step in the evaluation of the ingredient is to determine the digestibility of energy and nutrients. The standardized ileal digestibility of CP and AA is assessed using ileally cannulated pigs and the total tract digestibility of energy, DM, OM, ether extract, Ca, and P is also measured. The concentration of DE in the ingredient, and sometimes also ME, is then calculated and the concentration of NE may be calculated using the digestibility values for CP, ether extract, and OM and the concentration of starch in the ingredient. After determining energy and nutrient digestibility values, diets that contain graded levels of the ingredient can be formulated and fed to different categories of pigs. These diets are formulated to contain the same quantities of digestible energy and nutrients as a control diet, which is often a diet based on corn and soybean meal. Based on the results from these experiments, it is determined how much of the ingredient can be included in diets fed to pigs without compromising growth performance. If the ingredient is fed to finishing pigs, it may also be necessary to evaluate effects of the ingredient on the composition and the quality of the pork produced from pigs consuming diets that contain the ingredient.

Key Words: analyses, feed ingredients, ingredient evaluation, pigs

184 (Invited) Nutritional value of corn and soybeans: Historical trends and opportunities to manage variation. D. B. Jones, T. E. Sauber,* B. L. Smith, D. R. Rice, D. Sevenich, R. M. Allen, J. C. Iiams, and A. Hassen, *Pioneer Hi-Bred, Johnston, IA.*

Maize and soybean meal are key components of non-ruminant diets; and their value at any point in time strongly influences the value of other feed ingredients. There are clear trends in corn composition over the past 90 years. Corn starch concentration has increased 0.015% annually while protein concentration has decreased 0.014%, with little change in oil%. Similarly for soybeans, 30 years of data show a slight upward trend in oil concentration (+0.021% annually) accompanied by a slight downward trend in protein concentration (-0.031% annually). Within-year variations in composition are quite large; due primarily to genetics and to a lesser extent environmental diversity. For example, based on multi-year analysis, within-year standard deviations for corn protein (%DM), oil (%DM), starch (%DM) and digestible energy (DE, kcal/kg DM) are 1.20, 0.74, 1.75, and 13.78, respectively. Tools such as compositional regression, near-infrared (NIR) spectroscopy and hybrid specification are currently used to rapidly predict key nutritional traits such as swine DE and poultry apparent metabolizable energy (AME) with precision and accuracy. This creates the opportunity to capture the value of this within-year variation during diet formulation. Potential economic benefits provided by managing within-year corn variation

are significant; commercial models to maximize value capture while minimizing added costs or complexity continue to be investigated.

Key Words: corn, soybean meal, energy

185 (Invited) Evaluating the nutrient quality of co-product feedstuffs. R. T. Zijlstra*¹ and E. Beltranena^{1,2}, ¹*University of Alberta, Edmonton, AB, Canada,* ²*Alberta Agriculture and Rural Development, Edmonton, AB, Canada.*

Price increases for traditional feedstuffs such as cereal grains, protein meals, and fats have forced the pork industry to overcome their reluctance to use alternative feedstuffs. The major contributing factor was the rapid expansion of the biofuel industry. This industry produces co-products such as distillers dried grains with solubles (DDGS), canola meal (expeller-pressed, solvent-extracted), canola and camelina cake, and crude glycerol that complement a wide range of co-products from the food industry. Co-products can partially offset increases in feed costs, but also present risks and feeding challenges. First, processing of co-products adds variability in macronutrient profile beyond the intrinsic variability of feedstocks. Therefore, feed quality evaluation to profile digestibility of energy, AA, and P is as important as the energy and AA system selected for feed formulation. Moreover, characterization of functional characteristics of fiber beyond crude fiber, ADF, and NDF is required. Finally, rapid feed quality evaluation is needed to manage the risk of variation among batches of individual feedstuffs. Second, fermentation and heat processing impact AA and P availability. Overheating reduces lysine availability due to Maillard reactions, reduces heat-labile anti-nutritional factors, but combined with fermentation, may increase mineral availability due to partial breakdown of phytate. Third, co-products may contain chemical residues and mycotoxins such as deoxynivalenol that survive or are augmented by processing and reduce voluntary feed intake. Finally, co-product use may impact carcass characteristics and pork quality. Specifically, high fiber content reduces dressing percentage and high unsaturated fatty acid content softens pork fat. In conclusion, use of co-products from the biofuel industry may reduce feed costs per unit of pork produced, but also provides challenges to achieve cost-effective, predictable growth performance, carcass characteristics, and pork quality.

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

186 (Invited) Factors affecting the quality and energy content of fats. M. A. Dasari,* *Feed Energy, Des Moines, IA.*

Animal fats and vegetable oils represent one of the most important and widely used feed ingredients for poultry and livestock feed. Fats, in addition to possessing the highest concentrated energy value among the feed ingredients, also play significant role in improving the metabolic efficiency of the entire feed. In spite of its importance and prevalence, the factors effecting the quality and energy content of fats are not well understood. This presentation will outline various physical and chemical parameters that can affect the quality and energy content of the fat and methods to measure them.

187 (Invited) The impact of nutrient loadings on formulation and production. W. R. Cast*¹ and E. L. Hansen², ¹*Value Added Science & Technologies, Princeton, MO,* ²*New Fashion Pork, Jackson, MN.*

Productive formulation is the end result of proper nutrient requirements being set and those nutrient levels being met by the assembly of ingredients to meet those nutrient needs. Only when these processes work collectively can accurate formulation take place. Computer formulation software has improved the ease, frequency, and speed of diet changes. This ease and speed plus the demands of our society can lead to diet implementation with minimal amount of review. The expansion of knowledge particularly in the area of amino acids has resulted in formulation with more nutrient minimums than in the past. The increased availability and cost effectiveness of co-products/by-products offer challenges to swine nutritionists to utilize these products while maintaining cost effective performance. A key first step in formulation is to ensure that nutrient loadings for the ingredients in the formulation software are correct. While this may seem like a simple task, small errors in keystrokes, decimal placements, or unit conversions can have profound impact. While reviewing analytical data at

regular time periods provides current values, an important decision is how to use those values. Two approaches are commonly used: One, the analytical means for the ingredient nutrient loadings in conjunction with some margin of safety built into the nutrient minimums on the formula side. One downside to this approach is it does not appreciate the more consistent ingredients or discriminate against the more variable ones. The second approach is to take the mean of a value over a given period of time, then subtract a multiple of the standard deviation, commonly one half the standard deviation of the value. This method discounts the more variable ingredients and allows formula nutrient minimums to be set closer to the pig's requirement. A variety of examples can be used to illustrate how small changes in key nutrients can influence not only diet cost, but also animal performance. The impact of animal performance is difficult to measure due to inherent variation, but it is well proven that deficient nutrients levels will inhibit animal performance.

Nonruminant Nutrition: Nursery Nutrition

188 Effects of replacing commonly used specialty protein sources with crystalline amino acids on growth performance of nursery pigs from 6.8 to 11.3 kg. J. E. Nemecek,* M. D. Tokach, S. S. Drittz, R. D. Goodband, J. M. DeRouchey, and J. L. Nelssen, *Kansas State University, Manhattan.*

A total of 282 nursery pigs (PIC TR4 × 1050; initially 6.6 kg) were used in a 28-d growth trial to determine the effects of replacing high amounts of specialty protein sources with crystalline amino acids on growth performance. On d 3 after weaning, pigs were allotted to 1 of 6 treatments arranged as a 2 × 3 factorial with 7 replications per treatment. Five pens housed 7 pigs per pen and 2 pens housed 6 pigs per pen for each treatment. Treatment diets were fed from d 0 to 14 with a common diet fed from d 14 to 28. Treatment diets were corn-soybean meal-based with 10% dried whey and were formulated to 1.30% SID lysine and minimum amino acid:Lys ratios for Met and Cys (58%), Thr (62%), Trp (16.5%), Val (65%), and Iso (52%) and a maximum total Lys:CP ratio of 7.35%. The factorial included either low or high levels of crystalline amino acids and 3 specialty protein sources (fish meal, meat and bone meal, or poultry meal). Low and high crystalline amino acid diets contained 4.5 or 1% fish meal, 6 or 1.2% meat and bone meal, and 6 or 1% poultry meal, respectively. Pigs and feeders were weighed weekly to calculate ADG, ADFI, and G:F. There were no interactions ($P > 0.32$). From d 0 to 14, there were no differences ($P > 0.19$) between protein sources for ADG (251, 235, and 248 g), ADFI (374, 359, and 374 g), or G:F (0.67, 0.66, and 0.66). Increasing the level of crystalline amino acids fed during phase 1 improved ($P < 0.04$) ADG (255 vs 234) due to a tendency ($P < 0.14$) for improved ADFI (378 vs 360 g) and G:F (0.68 vs 0.65). During the common diet period (d 14 to 28), specialty protein source fed from d 0 to 14 did not influence ($P > 0.09$) ADG (519, 494, and 515 g) or ADFI (828, 814, 851 g), but pigs fed fish meal from d 0 to 14 had improved ($P < 0.03$) G:F (0.63, 0.61, 0.61) compared with pigs previously fed other specialty protein sources. There were no differences ($P > 0.38$) in growth performance from d 14 to 28 between the pigs previously fed different levels of crystalline amino acids. These results indicate that high amounts of fish meal, meat and bone meal, and poultry meal can be replaced in nursery pig diets when balancing for minimum amino acid ratios and a maximum Lys:CP ratio with no negative effect on growth performance.

Key Words: amino acid, nursery pig

189 Effect of partial or total replacement of dried whey permeate (DWP) with a blend of sugars and cooked cereals (Candy Oats, CO) on week-one feed intake and growth performance of weanling pigs. J. W. Charal,* A. M. Waguespack, V. D. Naranjo, T. D. Bidner, and L. L. Southern, *Louisiana State University, Agricultural Center, Baton Rouge.*

Two experiments were conducted to determine the effect of partial or total replacement of DWP (80% lactose) with CO (60% total sugars and 25% cooked oat-based cereals) on wk-1 daily feed intake and growth performance of weanling pigs. Diets were fed d 0–7 for phase 1, d 7–14 for phase 2, d 14–21 for phase 3, and d 21–35 for phase 4. In Exp. 1 (6 reps of 4 pigs per pen; BW = 6.4 ± 0.8 kg; 21 ± 2 d of age) and Exp. 2 (4 reps of 4 pigs per pen, BW = 6.2 ± 1.0 kg; 22 ± 1 d of age) pigs were assigned to 5 dietary treatment groups as follows: A) DWP, no SRO (total sugars provided by DWP and no steam rolled oats (SRO)); B) no DWP + SRO; C) DWP + SRO; D) 50CO (50% replacement of the total sugars provided by DWP in diet C and reduced SRO); and E) 100CO (100% replacement of the total sugars provided by DWP and further reduction of SRO). During phase 4, all pigs were fed a common corn-soybean meal diet. The levels of total sugars were 16, 8, and 3% for phases 1, 2, and 3, respectively (except no DWP + SRO diet). The data from the 2 experiments were combined for analysis. Pigs fed the 50CO diet ate more feed ($P < 0.10$) on individual days during the first week post-weaning compared with pigs fed the other 4 diets (d 1–3 compared with DWP with no SRO; d 1–7 with no DWP + SRO; d 1–6 with DWP + SRO; and d 1, 6, and 7 compared with 100CO diet). Daily gain was greater ($P < 0.10$) in pigs fed the 50CO diet compared with pigs fed 100CO, DWP with no SRO, DWP + SRO, and no DWP + SRO diets during phase 1 (236, 216, 211, 211, and 179 g/d, respectively), 21 d (371, 355, 349, 340, and 326 g/d; respectively), and through d 35 (481, 452, 444, 438, and 430 g/d; respectively). The response in ADG was due to an increase ($P < 0.10$) in ADFI. Gain:feed was not affected ($P > 0.10$) by diet in any period. This study indicates that CO can partially or totally replace DWP and SRO in diets for weanling pigs.

Key Words: sucrose, lactose, oats, pigs

190 An evaluation of Peptone products on nursery pig performance. A. J. Myers*¹, M. D. Tokach¹, R. D. Goodband¹, S. S. Dritz¹, J. M. DeRouchey¹, J. L. Nelssen¹, B. W. Ratliff², D. M. McKilligan², G. Xu³, J. Moline³, and M. Steidinger⁴, ¹Kansas State University, Manhattan, ²Tech Mix Inc., Stewart, MN, ³Midwest Ag Enterprises, Marshall, MN, ⁴Swine Nutrition Service, Anchor, IL.

Two studies were conducted to evaluate Peptone products (PEP 2+, PEP-NS, and Peptone 50; Tech Mix Inc., Stewart, MN) on nursery pig performance. In Exp. 1, 360 weanling pigs (initially 5.4 kg) were used with 5 pigs per pen and 12 pens per treatment. There were 6 dietary treatments: a negative control diet containing 2.5% spray-dried animal plasma (SDAP) in phase 1 followed by no specialty protein sources in phase 2; 5% SDAP in phase 1 and 3% select menhaden fish meal (SMFM) in phase 2; 5% SDAP and 3% SMFM during phase 1 and 6% SMFM during phase 2; 5% SDAP and 3% PEP2+ during phase 1 and 6% PEP2+ during phase 2; 5% SDAP and 3% PEP-NS during phase 1 and 6% PEP-NS during phase 2; and 5% SDAP and 3% PEP 50 during phase 1 and 6% PEP50 during phase 2. Overall, pigs fed PEP2+, Peptone 50 and PEP-NS had increased ($P < 0.05$) ADG and ADFI compared with pigs fed the negative control diet with others intermediate. Pigs fed PEP2+ had improved ($P < 0.05$) G:F compared with all other treatments. In Exp. 2, 1,152 weanling pigs (initially 5.6 kg) were used to evaluate the effects of SMFM, poultry meal (PM), PEP2+, Peptone 50, and PEP-NS on pig performance. There were 6 dietary treatments: negative control diet containing 3% SDAP in phase 1 and no specialty protein sources in phase 2 or the negative control diet with 6% PM, PEP2+, Peptone 50, or PEP-NS. There were 6 pens per treatment with 32 pigs per pen. From d 0 to 21, pigs fed 6% SMFM, PM, PEP2+, or PEP-NS had improved ($P < 0.05$) ADG compared with pigs fed the negative control diet or 6% Peptone 50. Pigs fed 6% PEP-NS had improved ($P < 0.05$) ADG compared with pigs fed the negative control, 6% PM, or 6% Peptone 50. Pigs fed 6% SMFM, PM, PEP2+, or PEP-NS had improved ($P < 0.05$) G:F when compared with the negative control or 6% Peptone 50. These results suggest PEP2+ and PEP-NS can replace SMFM and PM in nursery pig diets.

Table 1

Item	Negative Control	3% SMFM	6% SMFM	6% PEP2+	6% PEP-NS	6% Peptone 50	SEM
Exp. 1, d 0 to 21							
ADG, g	251 ^c	259 ^{bc}	266 ^{bc}	298 ^a	277 ^b	279 ^{ab}	14
G:F	0.780 ^a	0.778 ^a	0.797 ^a	0.834 ^b	0.784 ^a	0.775 ^a	0.011
Exp. 2, d 0 to 21							
	Negative control	6% SMFM	6% PM	6% PEP2+	6% PEP-NS	6% Peptone 50	SEM
ADG, g	199 ^a	242 ^{bc}	230 ^b	247 ^{bc}	256 ^c	197 ^a	9
G:F	0.693 ^a	0.706 ^{bc}	0.713 ^{bc}	0.715 ^{bc}	0.735 ^c	0.665 ^a	0.015

^{abc}Within a row, means without a common superscript differ $P < 0.05$.

Key Words: nursery pig, fish meal, Peptone

191 Effects of Liquitein on weanling pigs administered a porcine circovirus type 2 (PCV2) and *Mycoplasma hyopneumoniae* (M.hyo) vaccine strategy. A. J. Myers*¹, M. D. Tokach¹, R. D. Goodband¹, S. S. Dritz¹, J. M. DeRouchey¹, J. L. Nelssen¹, B. W. Ratliff², D. M. McKilligan², G. Xu³, and J. Moline³, ¹Kansas State University, Manhattan, ²Tech Mix Inc., Stewart, MN, ³Midwest Ag Enterprises, Marshall, MN.

A total of 180 nursery pigs (PIC 1050, initially 5.7 kg BW and 21 d of age) were used in a 35-d study to determine the effects of Liquitein and a PCV2 and M. *hyo* vaccine regimen on the growth performance of weanling pigs. Liquitein is a liquid source of nutrients provided through the water lines at a ratio of 1:50. Pigs were transported approximately 7 h (623 km) from the sow farm to the nursery and then randomly allotted to 1 of 4 treatments arranged in a 2 × 2 factorial with main effects of Liquitein (with or without) and PCV2 and M. *hyo* vaccine regimen (vaccinates or non-vaccinates). There were 5 pigs per pen and 9 pens per treatment. On d 0, pigs in the vaccinate group were given a full dose (2 mL) of each ResprisureOne (Pfizer Animal Health) and Circumvent (Intervet/Schering-Plough Animal Health, Millsboro, DE). On d 21, pigs in the vaccinate group were administered a second full dose (2 mL) of Circumvent as per label instructions. Liquitein was administered to the pigs via water medicators for the first 5 d after arrival to the nursery. There were no vaccine × Liquitein interactions ($P > 0.05$) for any response criteria. From d 21 to 35, pigs previously administered Liquitein had greater ADFI ($P = 0.05$) than those not provided Liquitein. However, overall (d 0 to 35) there were no effects of Liquitein on growth performance. From d 0 to 35, vaccinated pigs had decreased ($P < 0.01$) ADG and ADFI compared with non-vaccinated pigs. These results suggest that under these experimental conditions, administering Liquitein during the first 5 d in the nursery did not have any effect on growth performance; however, pigs administered the vaccine regimen had decreased ADG and ADFI.

Table 1. Effects of Liquitein and PCV2/M.hyo vaccine strategy on nursery pig performance

	Liquitein		No Liquitein		SEM	Vaccine	Liquitein
	Non-vaccinate	Vaccinates	Non-vaccinate	Vaccinates			
d 0 to 5							
ADG, g	175	160	162	135	12	0.07	0.11
G:F	1.674	1.599	1.489	1.529	0.09	0.85	0.18
d 0 to 35							
ADG, g	370	330	354	320	11	<0.11	0.21
G:F	0.671	0.666	0.669	0.664	0.02	0.76	0.88

Key Words: liquid supplement, PCV2, pigs

POSTER PRESENTATIONS

Nonruminant Nutrition

192 Sow fertility is improved by feeding diets supplemented with omega 3 fatty acids from fish oil during lactation through to early pregnancy. R. J. Smits*¹, M. Mitchell², B. G. Luxford¹, and M. B. Nottle², ¹Rivalea Australia Pty Ltd, Corowa, NSW, Australia, ²Robinson Institute and School of Paediatrics and Reproductive Health, The University of Adelaide, Adelaide, SA, Australia.

Feeding sows a diet supplemented with omega 3 PUFAs from fish oil fed pre-farrowing and during lactation has been reported to increase litter size in the subsequent parity. The aim of this study was to determine if there were added benefits when omega 3 supplemented diets continued to be fed during early pregnancy. At the start of lactation 1216 sows (parity 1–7, mean 3.7 ± 0.06) were fed one of 2 diets: either unsupplemented (Control lactation) with tallow (68 g/kg) or the same base diet supplemented with 3 g/kg of fish oil substituting v/v for tallow (Omega 3 lactation). Following weaning at 19.8 ± 0.1 d, sows continued on their lactation diet until estrus. In a 2x2 factorial design, a subset of 860 sows from Control and Omega 3 lactation treatments were fed either Control gestation containing tallow (10 g/kg) or a diet with 6 g/kg of fish oil (Omega 3 gestation) for 4 weeks from mating. Wean to estrus interval (WEI) and subsequent total born were analyzed in Univariate GLM ANOVA. There was no difference in WEI between sows on Omega 3 or Control diets (7.2 vs 6.8 d, $P = 0.268$). Across all parities Omega 3-Omega 3 sows tended to have larger litters following supplementation compared with Control-Control (12.6 vs 11.7, $P = 0.08$). Treatment differences were significant in older sows, with Omega 3-Omega 3 sows of parity 4–7 producing more piglets than Control-Control sows (12.8 vs 11.1, $P < 0.05$). Parity 4–7 sows fed Omega 3-Control (11.7) and Control-Omega (12.4) regimens had an intermediate litter size. Farrowing rates were similar between treatments (mean 83.1%, Chi-squared 3.45, $P = 0.327$). We conclude that supplementation with omega 3 fatty acids from fish oil fed to sows during lactation to early pregnancy improved subsequent litter size in older parities. Omega 3 supplementation offers producers a nutritional strategy to overcome declining productivity in older sows.

Key Words: pigs, omega 3, PUFA, litter size

193 Enterosorption therapy provided by Calibrin-Z enterosorbent after pigs were intoxicated by zearalenone. J. P. Wang*¹, I. H. Kim¹, S. W. Choi², J. Broomhead³, and F. Chi³, ¹Dankook University, Cheonan, Choongnam, South Korea, ²CTCBio, Seoul, South Korea, ³Amlan International, Chicago, IL.

The study was conducted to evaluate the effect of Calibrin-Z enterosorbent after pigs were intoxicated by zearalenone (ZEA). Sixty 4 female pigs were previously fed 0, 200, 400, or 800 ppb of ZEA (ZEA, University of Missouri, Columbia) contaminated diets for 28 d before the study. Sixteen pigs from each pre-fed ZEA treatment were randomly divided into half (4 replicate pens with 2 pigs each) and fed either a control diet (no detectable mycotoxins) or control + 0.2% Calibrin-Z (Amlan International, Chicago) for 18 d to form 8 treatments in a 4 by 2 factorial arrangement design (Table 1). Blood samples were collected on d-9 and d-18; serum malondialdehyde (MDA), superoxide dismutase (SOD), and liver enzymes such as aspartate aminotransferase (AST), alanine aminotransferase (ALT), and alkaline phosphatase (AP) were

analyzed. Pigs previously fed diets containing ZEA at 400 and 800 ppb had reduced ($P < 0.05$) ADG in the post-ZEA period compared with pigs previously fed a non-ZEA diet. Supplementation with 0.2% Calibrin-Z increased ($P < 0.05$) ADG in pigs pre-fed 200 (651 vs. 734 g), 400 (615 vs. 686 g), or 800 (617 vs. 690 g) ppb ZEA diets as compared with the pigs pre-fed the same ZEA diets. However, improved FE ($P < 0.05$) from Calibrin-Z feeding was observed in pigs pre-fed the 400 (757 vs. 832) ppb treatments, only. Pigs fed 0.2% Calibrin-Z reduced ($P < 0.05$) average vulva size through-out the 18 d period as compared with those pigs fed the control diet regardless of pre-fed ZEA dosage. The rate of vulva size reduction was significantly improved in pigs fed the Calibrin-Z diet, over those fed the control diet. Serum MDA was reduced ($P < 0.05$) in pigs fed Calibrin-Z supplementation on d-18 but not different on d-9; SOD increased ($P < 0.05$) in those pigs fed Calibrin-Z on d-9 but not different on d-18. In general, serum liver enzymes were not different between control and Calibrin-Z feeding, except the AP was lower ($P < 0.05$) in pigs pre-fed 800 ppb ZEA and continued on the control diet. The results suggested that Calibrin-Z may increase detoxification of ZEA in pigs possibly by preventing re-absorption of ZEA metabolites in the small intestine originating from bile (enterohepatic circulation); and it may be used to accelerate the recovery from ZEA intoxicated pigs.

Table 1. Experimental treatments

28 d pre-feeding, ppb	18 d feeding, (No detectable mycotoxins)
0	Control
0	Control + 0.2% Calibrin-Z
200	Control
200	Control + 0.2% Calibrin-Z
400	Control
400	Control + 0.2% Calibrin-Z
800	Control
800	Control + 0.2% Calibrin-Z

Key Words: zearalenone, oxidative stress, clay enterosorbent, pigs

194 The effects of diet modifications and flow agent on growth performance of nursery pigs fed high levels of deoxynivalenol. E. D. Frugé*¹, E. L. Hansen², S. A. Hansen¹, M. D. Tokach³, and H. L. Frobese³, ¹Hubbard Feeds Inc., Mankato, MN, ²New Fashion Pork, Jackson, MN, ³Kansas State University, Manhattan.

An experiment was conducted to determine the effect of pelleting, increased nutrient density, and the addition of the flow agent Defusion® (DEF; Provimi N.A., Inc., Brookville, OH) on growth performance of nursery pigs fed high levels of Deoxynivalenol (DON) from naturally contaminated DDGS (18.9 ppm DON). Mixed gender pigs (n = 1008, 12.5 kg) were allotted to 6 treatments (TRT) with 6 replicates and 28 pigs per pen. The experimental TRT were; 1) positive control (PC), < 0.5 ppm DON; 2) negative control (NC), 3 ppm DON; 3) NC + 0.25% DEF; 4) NC + 0.5% DEF; 5) NC + 0.25% DEF and increased nutrient density; and 6) as 5 (pelleted). All diets contained 15.85% clean or contaminated DDGS. Increased nutrient dense diets, (ME +6% and

TID Lys +10%), were achieved with increased SBM, crystalline AA and fat. Pig weights and feed disappearance were measured on d 0, 7, 14, and 24. A summary of the overall (d 0 to 24) results is presented in Table 1. Feeding 3 ppm DON resulted in reduced ADG and ADFI (PC vs. NC; $P < 0.02$). Pigs fed 0.5% DEF (TRT 4) had improved performance compared with the NC ($P < 0.01$) and similar to PC ($P > 0.10$) with pigs fed 0.25% DEF (TRT 3) having intermediary performance. Pigs fed TRT 6 had similar ($P > 0.10$) ADG and improved ($P < 0.01$) G:F compared with PC. These results suggest that 0.50% inclusion of DEF in meal diets or 0.25% inclusion of DEF in an increased nutrient dense pelleted diet can alleviate the negative impact of 3 ppm DON.

Table 1. The effect of DEF and diet modifications on growth performance of pigs fed high levels of DON

Treatment	1	2	3	4	5	6	SEM	P-value
d 0 to 24								
Initial BW, kg	12.44	12.59	12.53	12.47	12.57	12.58	0.15	0.98
ADG, g	622 ^{ab}	586 ^c	602 ^{bc}	619 ^{ab}	588 ^c	637 ^a	7.83	<0.01
ADFI, g	892 ^a	850 ^b	863 ^{ab}	883 ^a	798 ^c	818 ^c	10.90	<0.01
G:F	0.70 ^c	0.69 ^c	0.70 ^c	0.70 ^c	0.74 ^b	0.78 ^a	0.01	<0.01
Ending BW, kg	27.38 ^{ab}	26.65 ^b	26.99 ^b	27.33 ^{ab}	26.69 ^b	27.87 ^a	0.28	<0.04

^{abc} Within a row, means without common superscript differ ($P < 0.05$).

Key Words: deoxynivalenol, mycotoxin, nursery pigs

195 The effects of pelleting, increased nutrient density, and a flow agent on growth performance of nursery pigs fed high levels of deoxynivalenol. E. D. Frugé^{*1}, E. L. Hansen², S. A. Hansen¹, M. D. Tokach³, and H. L. Frobose³, ¹Hubbard Feeds Inc., Mankato, MN, ²New Fashion Pork, Jackson, MN, ³Kansas State University, Manhattan.

An experiment was conducted to determine the effects of pelleting, increased nutrient density (ME + 6% and TID Lys + 10%), and Defusion[®] (DEF; Provimi N.A., Inc., Brookville, OH) on growth performance of nursery pigs fed high levels of Deoxynivalenol (DON) from naturally contaminated DDGS. Pigs (n = 980, 12.0 kg) were allotted to 7 dietary treatments (TRT) with 5 replicates and 28 pigs per pen in a randomized complete block design. The experimental TRT were; 1) PC (meal), < 0.5 ppm DON; 2) PC (pellet); 3) NC (meal), 3 ppm DON; 4) NC (pellet); 5) NC (meal) + 0.25% DEF; 6) NC (pellet) + 0.25% DEF; and 7) as 6, with increased nutrient density. Pig weights and feed disappearance were measured on d 0, 7, 14, 21, and 28. A summary of the overall (d 0 to 28) results is presented in Table 1. Pigs fed meal diets with 3 ppm DON (TRT 3 and 5) had reduced ADG and ADFI compared with the PC meal diet (TRT 1). Pigs fed 3 ppm DON in pelleted form (TRT 4 and 6) had ADG similar to the PC pelleted diet (TRT 2) and similar or better G:F than TRT 2. Pigs fed pelleted diet + DEF (TRT 6) had improved G:F over those fed pelleted diet without DEF (TRT 5). Pigs fed the increased nutrient dense diet (TRT 7 vs. TRT 6) showed no improvement in performance. These results suggest that DEF or increased nutrient density did not improve performance. However, pelleting a diet with 3 ppm DON resulted in similar performance to the PC containing < 0.50 ppm DON.

Table 1. The effect of DEF and diet modifications on growth performance of pigs fed high levels of DON

Treatment	1	2	3	4	5	6	7	SEM	P-value
d 0 to 28									
Initial BW, kg	11.9	12.0	12.0	12.0	11.9	12.0	11.9	0.10	0.93
ADG, g	641 ^b	666 ^c	589 ^a	653 ^{bc}	603 ^a	663 ^{bc}	654 ^{bc}	9.64	<0.01
ADFI, g	995 ^c	988 ^c	912 ^a	950 ^b	934 ^{ab}	939 ^{ab}	937 ^{ab}	15.08	<0.01
G:F	0.64 ^d	0.67 ^c	0.65 ^d	0.69 ^{bc}	0.65 ^d	0.71 ^a	0.70 ^{ab}	0.01	<0.01
Ending BW, kg	29.9 ^b	30.6 ^c	28.5 ^a	30.4 ^{bc}	28.8 ^a	30.6 ^{bc}	30.2 ^{bc}	0.31	<0.01

^{abcd} Within a row, means without common superscript differ ($P < 0.05$).

Key Words: deoxynivalenol, mycotoxin, nursery pigs

196 Actigen increases serum levels of cytokines and haptoglobin in pigs experimentally infected with porcine reproductive and respiratory syndrome virus (PRRSV). T. M. Che^{*1}, M. Song¹, R. W. Johnson¹, K. W. Kelley¹, W. G. Van Alstine², K. A. Dawson³, and J. E. Pettigrew¹, ¹University of Illinois, Department of Animal Science, Urbana, ²Purdue University, Animal Disease and Diagnostic Laboratory, West Lafayette, IN, ³Research, Alltech Biotechnology Center, Nicholasville, KY.

Mannan oligosaccharide products alter inflammatory responses in pigs. A study was conducted to evaluate effects of Actigen (a refined yeast-based mannan preparation, Alltech, Inc.) on serum levels of cytokines and haptoglobin (Hp) in pigs infected with PRRSV. Weaned pigs (n = 64, 21 d old), free of PRRSV, were divided into blocks of 4 based on BW, sex, and litter origin. They were randomly assigned from within blocks to 1 of 4 treatments in a 2 × 2 factorial arrangement [2 types of diet: control (0%) and Actigen addition (0.04%); 2 levels of PRRSV: with and without]. Pigs (16/treatment) were kept individually in each pen. After 2 wk of an 8-wk period of feeding the treatments, pigs were intranasally inoculated with PRRSV or a sterile medium (Sham) at 5 wk of age. Serum cytokines and Hp were measured at d 0, 3, 7 post-inoculation (PI), and subsequently weekly until d 42 PI. Data were analyzed as repeated measures over time using the MIXED procedure of SAS. Infection by PRRSV increased the levels of tumor necrosis factor (TNF)- α ±, IL-1 β , interferon (IFN)- γ , IL-10, IL-12, and Hp in the infected pigs ($P < 0.001$). The levels of these inflammatory mediators increased at d 3 PI (except Hp at d 7 PI), peaked at d 14 PI (except IFN- γ at d 7 PI), and then declined to normal by d 35 PI, whereas IL-10 increased at d 14 PI and reached the highest level at d 35 PI. These results indicate PRRSV-induced secretion of cytokines involved in innate, T-helper 1, and T-regulatory responses. Actigen enhanced IL-1 β (18.3 vs. 14.0 pg/mL; $P = 0.019$), but decreased TNF- α ± (129.1 vs. 141.6 pg/mL; $P = 0.058$). It also increased levels in infected pigs but not in Sham, specifically IL-1 β ($P = 0.016$) and IL-12 ($P = 0.026$) at d 7 PI, Hp ($P = 0.047$) at d 14 PI, and IL-10 ($P = 0.088$) at d 21 PI. The IL-1 β and IL-12 favorably promote innate and T cell immune functions, whereas IL-10 is anti-inflammatory and capable of stimulating B cell-produced antibody. Briefly, the modulation of secretion of inflammatory mediators by Actigen at critical time points may enhance protection against PRRSV and secondary bacterial infections.

Key Words: actigen, pigs, PRRSV

197 Effects of actigen in nursery pig diets under commercial conditions. J. A. Soares,* M. Song, T. M. Che, and J. E. Pettigrew, *University of Illinois, Urbana.*

Mannan oligosaccharide makes important contributions to animal production. A refined yeast based mannan product is being marketed: Actigen® (AC), Alltech Inc. This experiment measured its effects on performance and health of young pigs. Weanling pigs (n = 1008; 6.2 ± 1.1 kg of BW; 21 d of age) were used in a randomized complete block design with pen as the experimental unit. There were 4 rooms with 12 pens/room and 21 pigs/pen. Pigs were blocked by weight (3 blocks: heavy, medium, and light) within each room and each block had 4 pens with the same number of barrows and gilts. Pigs were assigned to 4 different dietary treatments in a 2 × 2 factorial arrangement: with or without antibiotic (AB) and with or without 0.04% AC. The AB was 35g of tiamulin and 400g of chlortetracycline per ton of feed. The dietary treatments were fed for 6 wks after weaning in a 4-phase (P) program with declining diet complexity: P-1: wk 1 (7 or 8 d), P-2: wk 2, P-3: wks 3 and 4, P-4: wks 5 and 6. The ADG, ADFI, G:F, and % mortality were measured by each phase and overall. Initial weight and performance were greater and % mortality was lower than in previous experiments in this facility. The AC increased ADFI in P-1 and ADG and ADFI in P-2 in the absence of AB, but reduced ADFI in the presence of AB (interaction: $P < 0.05$). The values for no AB or AC, AC only, AB only and both AC and AB were: P-1 ADFI (151.4, 163.5, 179.5, and 171.2 g/d); P-2 ADFI (320.8, 339.8, 378.9, and 352.5 g/d); P-2 ADG (296.5, 306.8, 353.2, and 332.4 g/d). During P-3, there was a tendency ($P = 0.06$) that AC reduced ADG (318.8 vs. 333.2 g/d) and G:F (0.57 vs. 0.59). During P-4, AC reduced ADFI (925.0 vs. 949.3 g/d; $P < 0.05$) and tended to reduce % mortality (1.2 vs. 2.6%; $P = 0.10$). During each phase, AB improved the growth performance. During the overall 6-wk period, AB increased ($P < 0.01$) ADG (372.5 vs. 330.9 g/d) and ADFI (605.8 vs. 551.6 g/d) and reduced (0.8 vs. 3.0%; $P < 0.05$) % mortality. In conclusion, AC did not improve growth performance but tended to reduce % mortality.

Key Words: actigen, weanling pig, performance

198 The influence of Hamlet protein 300 and fish meal on nursery pig performance. W. Ying,* J. M. DeRouche, R. D. Goodband, M. D. Tokach, S. S. Dritz, and J. L. Nelssen, *Kansas State University, Manhattan.*

A total of 360 nursery pigs (PIC 1050 barrows) were used in a 24-d study to evaluate the effects of nursery diets containing Hamlet Protein 300 (HP 300) or select menhaden fish meal on growth performance. Pigs were weaned at 21 d of age and fed a pre-test diet for 7 d before treatments were initiated. Pens of pigs were balanced by initial BW (7.4 kg BW) and randomly allotted to 1 of 7 dietary treatments with 9 replications per treatment. Treatments included a 10% dried whey corn-soybean meal control diet containing no specialty protein sources or the control diet with 2, 4 or 6% select menhaden fish meal; or the control diet with 2, 4, or 6% HP 300. All experimental diets were fed for 14 d followed by a common diet for 10 d. From d 0 to 14, neither fish meal nor HP 300 influenced growth performance ($P > 0.13$). During the common period (d 14 to 24), pigs previously fed fish meal tended to have better G:F than pigs previously fed HP 300 ($P = 0.09$). Overall (d 0 to 24), there was no difference in growth performance between treatments ($P > 0.43$). In conclusion, HP 300 and fish meal had similar effects on growth performance, but neither provided a benefit compared with the pigs fed the control diet.

Table 1. Effects of Hamlet Protein 300 and fish meal on nursery pig performance

Item	Control	2%	4%	6%	2% HP 300	4% HP 300	6% HP 300	SEM	P-value
		fish meal	fish meal	fish meal					
d 0 to 14									
ADG, g	386	387	389	380	376	367	367	13.2	0.82
ADFI, g	520	532	525	512	511	513	509	21.3	0.92
G:F	0.75	0.73	0.74	0.74	0.74	0.71	0.72	0.02	0.78

Key Words: fish meal, Hamlet protein 300, pig

199 Effects of incorporation of a yeast-dried milk product in creep feeding and Phase-1 nursery diets on growth performance and circulating immunoglobulin A of pigs. H. Tran,* J. W. Bundy, E. E. Hinkle, T. E. Burkey, and P. S. Miller, *University of Nebraska, Lincoln.*

Two feeding experiments were conducted to evaluate the effects of incorporation of a yeast-dried milk product in creep feeding and phase-1 nursery diets. In Exp. 1, 24 sows and their litters were assigned to pen based on anticipated farrowing date. Dietary treatments included: 1) No creep, 2) Control creep (CTL), and 3) Experimental creep (10% yeast-dried milk) and were randomly allotted to pen (8 litters/treatment). Creep diets (1.50% true ileal digestible Lys) were fed ad libitum from d 7 after birth until weaning (d 21) in a pan creep feeder. Pigs fed experimental and CTL creep diets tended to have greater (6.68 and 6.62 vs. 6.08 kg; $P = 0.10$) weaning BW compared with pigs not receiving creep feed. Pigs fed experimental creep had greater (21.7 vs. 13.6 g, $P = 0.002$) ADFI compared with pigs fed the CTL. In Exp. 2, a total of 108 weaned pigs were selected based on the mean BW of pigs from each of the 3 treatments in Exp. 1 and randomly allotted to one of 18 pens (6 pigs/pen, 6 pens/treatment). Creep diets from Exp. 1 were continually fed during phase 1 (d 0 to 7) followed by a common diet during phase 2 (d 7 to 21) and phase 3 (d 21 to 28). Thus, pigs that received creep diets during the nursing period received the same diet during phase 1. Pigs fed experimental creep had greater BW compared with CTL and non-creep fed pigs ($P < 0.05$) during wk 1 to 3. Overall (d 0 to 28), pigs fed experimental creep had greater (528 vs. 452 and 421 g; $P = 0.03$) ADG and ADFI (731 vs. 592 and 647 g; $P = 0.002$) compared with the CTL and non-creep fed pigs. At weaning, pigs fed CTL creep had greater ($P = 0.03$) immunoglobulin A compared with non-creep fed pigs; however, there were no differences among pigs fed experimental creep and other treatments. At the end of phase 1 (d 7), greater ($P = 0.03$) circulating immunoglobulin A was observed in pigs fed experimental creep compared with non-creep fed pigs.

Key Words: creep feeding, growth, immunoglobulin A, pig

200 Influence of herbal powder on growth performance, nutrient digestibility, blood characteristics, and meat quality in finishing pigs. Q. W. Meng,* I. H. Kim, J. H. Jung, B. U. Yang, and P. Y. Zhao, *Dankook University, Department of Animal Resource & Science, Cheonan, Choongnam, South Korea.*

A total of 144 [(Landrace × Yorkshire) × Duroc] finishing pigs with initial body weight (BW) of 50.09 ± 0.51 kg were used in a 10-week trial to evaluate the effect of 2 kinds of herbal powder (HA: tumeric and hearleaf houttuynia complex; HB: taraxacum herb and arrowroot complex; Doosan Feed Inc., Bucheon, South Korea) on growth performance, nutrient digestibility, blood characteristics, and meat quality.

Pigs were randomly allotted to 1 of 3 dietary treatments in a randomized complete block design according to their sex and BW (12 replicates with 4 pigs per pen, 2 gilts and 2 barrows). Dietary treatments included: 1) CON (basal diet), 2) HA (basal diet + herbal powder A 0.1%), and 3) HB (basal diet + herbal powder B 0.1%). The Longissimus muscle (LM) area was measured by tracing the LM surface at the 10th rib, which was conducted using the aforementioned digitizing area-line sensor. Pigs fed HA and HB diets improved ($P < 0.05$) average daily gain (ADG) by 11.5 and 9.1% (0 to 5 weeks) and 9.9 and 7.7% (0 to 10 weeks) when compared with those fed CON diet, respectively. The HA treatment pigs increased ($P < 0.05$) ADG by 8.7% when compared with the CON treatment pigs during 5 to 10 weeks. Meat LM area in herbal powder supplemental diets was improved ($P < 0.05$) compared with those fed CON diet. No other effects were observed ($P > 0.05$) on feed intake, nutrient digestibility, blood characteristics and other meat quality criteria. In conclusion, the supplementation of herbal powder could improve growth rate and meat LM area of finishing pigs.

Key Words: blood characteristics, herb, growth performance, pig

201 Effect of commercial feed additives in nursery and finishing pig diets containing DDGS on nutrient digestibility and growth performance. B. J. Kerr^{*1}, T. E. Weber¹, and G. C. Shurson², ¹USDA-ARS-NLAE, Ames, IA, ²University of Minnesota, St. Paul.

Ten commercially available feed additives (Allzyme SSF, Bactocell, BioPlus 2B, Econase XT25, Hemicell, Prozyme 9302, Releez-a-zyme 4M, Rovabio AP 10%, Roxazyme G2G, XPC yeast) were selected based on their potential to affect energy and fiber digestion, or their ability to modulate gastrointestinal bacterial ecology. A total of 192 nursery pigs (11.9 kg initial BW) and 96 finishing pigs (98.4 kg initial BW) were allotted to individual stainless steel pens and fed their respective diets for 5-wk. Diets contained corn, soybean meal, and 30% dried distillers grains with solubles (DDGS), were adequate in all nutrients (NRC, 1998), and were offered ad libitum in meal form. Additives were added at the recommended rates and were assumed to contain the active ingredients and activity level listed on the product label. Titanium dioxide was added as an indigestible marker to determine apparent DM, C, N, S, EE, ADF, and NDF digestibility at the end of wk 1, 3, and 5. Data were analyzed using ANOVA with group, room, gender, week, and diet included in the model. There were no week \times diet interactions. In nursery pigs, digestibility of most nutrients were unaffected by additives. Roxazyme tended to improve N and S digestibility ($P < 0.1$), and Rovabio and BactoCell tended to improve ($P < 0.06$) S digestibility compared with the unsupplemented control diet. However, Porzyme and Hemicell tended to decrease ($P < 0.09$) NDF digestibility, and Econase, Allzyme, and Rele-e-zyme decreased digestibility of various nutrients. Additives had no effect on ADG, ADFI, and G:F ($P > 0.1$). For finisher pigs, all additives had minimal effects on digestibility of most nutrients. Roxazyme tended to improve ($P < 0.08$) EE, and Allzyme and Bioplus2B tended to improve ($P < 0.1$) ADF digestibility. Addition of Porzyme, Hemicel, Rel-e-enzyme, XPC yeast and BactoCel caused negative effects on digestibility of various nutrients. Additives had no effect on finishing pig growth performance. In conclusion, addition of these commercial additives to corn-soybean meal-30% DDGS diets have minimal effects on nutrient digestibility in nursery and finishing pigs, and do not improve growth performance.

Key Words: swine, enzymes, DDGS

202 Evaluation of a chocolate candy product in diets for weanling pigs. G. L. Cromwell,* H. J. Monegue, and M. D. Lindemann, University of Kentucky, Lexington.

A chocolate candy product (CCP, International Ingredient Corp., St. Louis, MO) is a potential feed ingredient derived from chocolate, high sugar candies, and other chocolate food products. It is high in fat and readily digestible sugars. Typically, it contains 50% total sugars, 10% fat, 7% CP, 1.5% crude fiber, 6% ash, 0.28% Lys, 0.20% Ca and 0.34% P. The CCP used in this study analyzed 96.2% DM, 49.3% total sugars, 6.98% CP, 14.9% fat, 0.30% Lys, 0.22% Thr, 0.16% S-AA, and a calculated ME of 4,317 kcal/kg. A 21-d experiment involving 128 crossbred pigs weaned at 19.7 d of age and averaging 6.1 kg BW was conducted to assess CCP as a partial replacement for lactose in phase I (7 d) and phase II (14 d) starter diets. Four diets were fed to 8 replicate pens of 4 pigs each. In phase I, Diet 1 was corn, soybean meal, fish meal, and dried plasma fortified with soy oil, AA, minerals, vitamins, carbadox, and ZnO. Lactose was included at 20% in Diet 2. CCP was substituted on a total sugar basis for a portion of the lactose in Diets 3 and 4 to replace 25 or 50% of the sugar provided by lactose. Phase II diets were similar except that plasma was deleted, lactose was reduced to 15%, and CuSO₄ replaced ZnO. Levels of Lys, Thr, S-AA, Ca, P, and total sugars were constant across all diets in both phases. Calculated ME across diets was made constant by adjusting soy oil. Lys levels in the 2 phases were 1.5 and 1.3%, respectively. Pigs fed Diet 3 during phase I consumed more feed ($P < 0.03$) than those fed the other diets (92, 122, 177, 121 g/d for treatments 1–4, respectively) and they gained faster ($P < 0.03$) than those fed Diets 1 or 2 (12, 40, 109, 61 g/d). Over the entire test period, pigs fed the CCP diet at 25% sugar replacement (Diet 3) gained faster ($P < 0.01$) and consumed more feed ($P < 0.02$) than controls (Diet 1) or those fed the 50% sugar replacement (Diet 4), but feed:gain was not affected ($P = 0.89$) by diet (342, 367, 393, 342 g/d; 461, 501, 525, 462 g/d; 1.35, 1.36, 1.34, 1.35). The results indicate that the chocolate candy product at a 25% replacement for lactose, on a sugar basis, is effective in phase I and phase II nursery diets for early-weaned pigs.

Key Words: pigs, lactose, chocolate candy

203 Impact of a fermented soybean meal product and/or a candida utilis yeast product on nutrient utilization and growth performance of weanling pigs. J. F. Patience,* A. L. Chipman, and C. K. Jones, Iowa State University, Ames.

The unique sensitivity and requirements of the weanling pig gastrointestinal tract has prompted development of specialized protein sources and feed additives in an attempt to improve overall performance. Fermentation of soybean meal (FSM) represents one approach to developing specialized protein products for weanling pigs. The use of a candida utilis yeast extract (CY) represents an approach to supplying complex mannans and B-glucans in the diet of weanling pigs. The objective of this experiment was to evaluate these 2 products alone or in combination on weanling pig growth performance. A total of 400 pigs assigned to 40 pens of 10 pigs each were used to evaluate 5 dietary treatments: a negative control diet (NC) consisting of corn, soybean meal (SBM) and 15% dried whey, a positive control diet (PC) that was similar to NC except 7% select menhaden fish meal replaced 15% SBM, a treatment diet similar to the PC except the fish meal was replaced with 10% FSM, a treatment diet identical to NC except 0.25% CY was added at the expense of corn and a treatment diet consisting of both FSM (10%) and CY(0.25%). All diets were formulated to constant SID lysine, ME, calcium and phosphorus and minimum amino acid ratios to lysine.

The 21-d experiment employed weanling pigs with an average initial weight of 6.5 kg. There was no effect of diet on average daily gain or average daily feed. However, during the first week of the experiment, CY increased feed conversion compared with NC and PC ($P < 0.05$). PC reduced feed conversion (0.73) compared with NC (0.77), FSM (0.80), CY (0.82) and FSM and CY (0.79; $P < 0.05$). Over the 21-d experiment, CY increased feed conversion (0.69) compared with NC (0.66), PC (0.65) and FSM plus CY (0.66; $P < 0.05$). There was no difference between CY and FSM (0.67; $P > 0.05$). In conclusion, FSM replaced fish meal or part of the soybean meal with no loss in performance, while the use of CY improved feed efficiency.

Key Words: swine, weanlings, fermented soybean meal, candida utilis yeast

204 The influence of the mannan oligosaccharide Bio-Mos® on sow and piglet performance. W. H. Close¹, J. A. Pickard², and K. A. Jacques^{*3}, ¹Close Consultancy, Wokingham, Berkshire, United Kingdom, ²Alltech Inc., Dunboyne, Co. Meath, Ireland, ³Alltech Inc., Nicholasville, KY.

A review of 12 studies has been carried out and a summary prepared on the effects of Bio-Mos® in sow diets on both sow and piglet performance. Bio-Mos® had been included at 1 kg/ton during both gestation and lactation, or 2 kg during late gestation and lactation. The number of sows on the various commercial and university trials in several countries was 2,996 and varied between 24 and 1,028 sows over a range of parities in the different trials. Data were analyzed with Bio-Mos® inclusion as the main effect to determine its impact on sow and pre-weaning piglet performance. Including Bio-Mos® in the diet of the sow did not influence the number of piglets born alive (11.24 vs 11.14) ($P > 0.05$), but the number of piglets weaned was numerically higher in all studies: 10.11 (± 1.09) vs 9.67 (± 0.74) ($P > 0.05$). This increase resulted from a 21.0% decrease in pre-weaning mortality, from 11.56 (± 1.85) to 9.13 (± 1.60)%, respectively ($P < 0.05$). The birth weight of the piglets from sows fed Bio-Mos® was similar to that from control fed sows, but weaning weight was increased from 6.87 to 7.17 kg ($P > 0.05$). However, the difference was significant ($P < 0.05$) in 4 of the studies. Colostrum samples were collected in 5 of the studies and Ig concentrations measured. The concentration of IgA, IgM and IgG (mg/dl) was considerably increased when Bio-Mos® was included in the diet of the sow and in several studies the difference was significant ($P < 0.05$). In 2 studies, piglet growth rate was measured during the first 24 h of life and was increased from 83 to 123 g/day and 138 to 164 g/day, respectively ($P < 0.05$), when Bio-Mos® was included in the diet. The responses to Bio-Mos® in sow diets are therefore consistent, with considerable benefits for both sow and piglet productivity.

Key Words: mannan oligosaccharide, pre-weaning mortality, piglets, sows

205 The effects of Biomin Product A and vomitoxin on growth performance of nursery pigs. H. L. Frobose^{*1}, M. D. Tokach¹, K. Soltwedel², J. M. DeRouchey¹, S. S. Dritz¹, R. D. Goodband¹, and J. L. Nelssen¹, ¹Kansas State University, Manhattan, ²Biomin USA, San Antonio, TX.

A total of 340 barrows (initially 11.6 kg BW and 35 d of age) were used in a 28-d growth trial examining the effects of adding Biomin Product A (Biomin; Herzogenburg, Austria) to diets contaminated with vomitoxin on nursery pig growth performance. Also, 5% water was

added in a diet with Product A as a means of potentially enhancing the activity of the product. Pigs were allotted to pens by weight, and pens were assigned to 1 of 8 treatments in a randomized complete block design. There were 9 pens per treatment and 4 to 5 pigs per pen. Based on initial mycotoxin analysis, dietary treatments were formulated to contain: (1) no vomitoxin or Product A, (2) 1.5 mg/kg vomitoxin and no Product A, (3) 1.5 mg/kg vomitoxin and 0.15% Product A, (4) 1.5 mg/kg vomitoxin and 0.30% Product A, (5) 3.0 mg/kg vomitoxin and no Product A, (6) 3.0 mg/kg vomitoxin and 0.30% Product A, (7) 3.0 mg/kg and 0.45% Product A, and (8) 3.0 mg/kg vomitoxin and 0.45% Product A with 5% water added to the diet. Corn dried distillers grains with solubles containing vomitoxin were used to increase vomitoxin concentrations in the treatment diets. After feed manufacturing, ingredients and diets were analyzed at 2 separate labs. Vomitoxin levels for the low- (1.5 mg/kg) and high- (3.0 mg/kg) vomitoxin diets were determined to average 2.5 and 5.2 mg/kg, respectively. Experimental diets were fed in meal form from d 0 to 21. Overall (d 0 to 21), pigs fed high-vomitoxin diets had decreased ($P < 0.01$) ADG (518 vs 565 g) and ADFI (838 vs 913 g) compared with pigs fed diets lower in vomitoxin concentration. Adding Biomin Product A to vomitoxin diets had no effect ($P \geq 0.24$) on ADG; however, adding Product A to low-vomitoxin diets increased (quadratic, $P < 0.01$) ADFI, resulting in poorer (quadratic, $P < 0.01$) G:F. Furthermore, there were no differences ($P \geq 0.38$) in performance or feed efficiency when 5% water was added. In conclusion, adding Biomin Product A to the diet did not improve nursery pig performance during the 3-week period during which diets containing low or high concentrations of vomitoxin were fed.

Key Words: mycotoxin, nursery, vomitoxin

206 The effects of feed budgeting, complete diet blending, and corn supplement blending on finishing pig growth performance in a commercial environment. H. L. Frobose^{*1}, J. M. DeRouchey¹, D. Ryder², M. D. Tokach¹, S. S. Dritz¹, R. D. Goodband¹, and J. L. Nelssen¹, ¹Kansas State University, Manhattan, ²Feedlogic Corp., Willmar, MN.

A total of 808 pigs (initial BW = 35.6 kg) were used to compare feed-blending strategies for finishing pigs using the FEEDPro system (Feedlogic Corp., Willmar, MN). FEEDPro is a feed dispensing system that can deliver and blend 2 diets while dispensing. There were 10 pens/treatment and 26 to 27 pigs per pen in a completely randomized design. There were 3 experimental treatments: (1) standard 4-phase complete feed program (Phase), (2) blending a high- and low-lysine complete diet (Curve; daily blending of the 2 complete diets to meet the estimated daily SID lys requirement from d 0 to d 88), and (3) blending ground corn and a supplement to mimic diets fed in 4 phases in treatment 1 (Blend). Experimental diets were fed from d 0 to 88 (~35 to 108 kg BW) with a common diet containing ractopamine HCl fed from d 88 to 110 (~108 to 127 kg BW). Overall (d 0 to 110), pigs phase-fed had greater ($P < 0.04$) ADG than pigs fed the curve or the blend. Pigs fed the curve had lower ($P < 0.05$) ADFI than pigs phase-fed or fed the blend. However, pigs fed the curve had improved ($P < 0.04$) G:F compared with the blend. Pigs phase-fed had heavier (95.3 vs. 92.5 kg; $P < 0.03$) HCW than pigs fed the blend and tended to have heavier (95.3 vs. 93.3 kg; $P < 0.07$) HCW than curve pigs. However, there were no differences ($P \geq 0.11$) in percentage yield, percentage lean, fat depth, or loin depth. There were no differences ($P \geq 0.11$) in total revenue or income over feed costs (IOFC). In conclusion, finishing pigs fed the various feeding strategies had differences in growth performance, however revenue and profitability as measured by IOFC was not affected.

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

Criteria	Phase feeding	Diet blending	Corn-supplement	SEM
ADG, kg	0.86 ^b	0.83 ^a	0.84 ^a	0.008
ADFI, kg	2.51 ^b	2.37 ^a	2.45 ^b	0.027
G:F	0.34 ^a	0.35 ^b	0.34 ^a	0.003
Feed cost, \$	52.38 ^a	50.06 ^b	51.94 ^a	0.467
Revenue/ pig, \$	147.35	145.94	144.87	1.365
IOFC, \$	94.40	95.88	93.45	1.253

^{a,b}. $P < 0.05$.

Key Words: feed blending, growth, carcass characteristics

207 Effect of increasing concentrations of two thermal stable strains of beta-mannanase in corn-soybean meal based diets on individually housed nursery pig performance. Z. Rambo^{*1}, J. Ferrel², D. Anderson², D. Kelly¹, and B. Richert¹, ¹Purdue University, West Lafayette, IN, ²ChemGen Corp, Gaithersburg, MD.

Forty 8 pigs (initial BW = 5.9 ± 0.01 kg; 20 d age) were used to evaluate the effect of 2 strains of thermal stable β-mannanase enzymes (HTs1 and HTs2), titrated at 3 concentrations in a corn-soybean meal based diets on pig growth, feed efficiency, and overall performance during the nursery period. Pigs were allocated in a randomized complete block design into individual pens, stratified by litter and initial BW, to 7 treatments, with 6 (T1) or 7 (T2-T7) pens/treatment. Dietary treatments were: Negative Control (T1; 3.5, 1.0, and 1.0% added fat phase 1, 2, and 3, respectively), T1 plus enzymes for treatments T2 (HTs2, 0.02 MU/kg), T3 (HTs2, 0.04 MU/kg), T4 (HTs2, 0.06 MU/kg), T5 (HTs1, 0.02 MU/kg), T6 (HTs1, 0.04 MU/kg), T7 (HTs1, 0.06 MU/kg). Pigs were fed 3 dietary phases, a common phase 1 (d 0 to 7) to acclimate from weaning onto dry feed, phase 2 (d 7 to 17), phase 3 (d 17 to 31). Individual BW and feed disappearance were recorded weekly. Phase 2 ADG and G:F numerically improved with increasing concentrations of HTs1 and HTs2. Phase 3 ADG tended to increase (linear, $P < 0.09$) with increasing concentrations of HTs1. Phase 3 ADFI decreased linearly with increasing concentrations of HTs2 ($P < 0.04$) and HTs1 ($P < 0.01$) with G:F tending to improve (quadratic, $P < 0.09$) with HTs1 while HTs2 numerically ($P > 0.16$) improved G:F. Overall, inclusion of HTs2 significantly improved G:F (linear, $P < 0.03$) while HTs1 tended to improve G:F (quadratic, $P < 0.06$) (0.644, 0.679, 0.704, 0.711, 0.723, 0.722, 0.710 ± 0.023, treatments 1–7, respectively). While additional work is needed to precisely define the response surface in relation to dietary composition, the improvements in G:F and gain indicate the enzyme's potential in nursery pig diets. These data also demonstrate minimal differences in the nursery pig performance response between the 2 thermal stable strains of β-mannanase.

Key Words: Beta-mannanase, thermal stable, swine, growth

208 Evaluation of lipid peroxidation level in corn dried distillers grains with solubles (DDGS). R. Song,^{*} A. S. Csallany, and G. C. Shurson, University of Minnesota, Saint Paul.

Lipid peroxidation in animal feed has been shown to have a negative impact on health, growth performance and meat quality. The objective of this study was to evaluate the lipid peroxidation level

in DDGS samples from 31 ethanol plants in the US, and the correlation among indicators of lipid peroxidation. An unaltered corn sample was obtained from a corn processing plant to use as a reference. Oils were extracted with hexane and analyzed for thiobarbituric acid reactive substances (TBARS) and peroxide value (PV). Extracted oil from DDGS samples ranged from 7.3 to 12.0% with an average of 10.4%. The TBARS assay was conducted in triplicate for each sample, and results were reported as ng malondialdehyde (MDA) equivalents/mg oil. The TBARS values for DDGS samples ranged from 1.0 to 5.2 ng MDA equivalents/mg oil. The DDGS sample with the highest TBARS value was 25 times greater than that of the reference corn sample (0.2 ng MDA equivalents/mg oil). Peroxide values of DDGS samples ranged from 4.2 to 84.1 mEq/kg oil. The highest PV among DDGS samples was 27 times greater than that of the reference corn sample (3.1 mEq/kg oil). Color of DDGS samples was measured by Minolta L*, a* and b* corresponding to the degree of lightness, redness and yellowness, respectively. The correlations between TBARS, PV, and color were determined using the Corr procedure of SAS. Values of TBARS and PV were positively correlated ($r = 0.81$; $P < 0.0001$). Both TBARS and PV were negatively correlated with L* ($r = -0.73$; $P < 0.0001$, and $r = -0.63$; $P < 0.0002$, respectively) and b* ($r = -0.67$; $P < 0.0001$, and $r = -0.57$; $P < 0.001$, respectively), which means that darker and less yellow colored DDGS is more likely to have a higher lipid peroxidation level, as measured by TBARS and PV, compared with lighter colored DDGS samples. However, a* was not correlated with either TBARS ($P = 0.66$) or PV ($P = 0.97$). These results indicate that color can be a preliminary indicator of lipid peroxidation level in DDGS, but the exact level of peroxidation is more accurately measured by TBARS and PV.

Key Words: DDGS, lipid peroxidation, TBARS, PV

209 Determining the optimum dietary SID isoleucine and valine to lysine ratios in weaned pigs. S. A. Hansen^{*1}, E. L. Hansen², and K. A. Frerichs¹, ¹Hubbard Feeds Inc., Mankato, MN, ²New Fashion Pork, Jackson, MN.

Dietary SID valine (Val) and isoleucine (Ile) to lysine (Lys) ratios are important to refine due to the commercial availability of L-Val and the variability of specialty proteins. Pigs (FAST X TR4; n = 1008; BW = 5.94 kg) were randomly allotted to 6 dietary treatments, 6 replicate pens/ treatment with 28 mixed gender pigs/pen. Feed disappearance and pig weights were taken on d 5, 16, and 27. A common phase 1 diet was fed d 0 to 5. The negative control (NC) diet in phases 2 and 3 used mostly intact protein sources to meet the desired lysine level (1.4, 1.25% SID Lys, respectively). The positive control (PC) diet was as NC plus added crystalline amino acids to meet the minimum amino acid requirement ratios (1.55, 1.4% SID Lys, respectively). Remaining diets were formulated to the same Lys level as the NC with varying SID Ile and Val:Lys ratios as shown in Table 1. Pigs fed diets formulated to either 0.50 Ile:Lys or 0.65 Val:Lys ratios had improved ADG in phase 2 ($P < 0.05$). This indicates that 0.45 and 0.60 SID Ile and Val ratios were below the requirement in this phase. There were no performance differences for pigs fed 0.55 vs. 0.50 SID Ile:Lys in phase 3. Pigs fed diets containing 0.67 SID Val:Lys had improved ADG over pigs fed a ratio of 0.62 ($P < 0.05$). The SID Ile:Lys ratio for pigs 5–27 d post-weaning is no greater than 0.50. The SID Val:Lys requirement was found to be between 0.65 and 0.67:1.

Table 1.

Phase 2, d 5-16							
	NC.50/	.45/	.45/	.50/	.50/	PC .50/	
SID Ile & Val:Lys	.65	.60	.65	.60	.65	.65	SEM
ADG	283 ^c	227 ^a	259 ^b	251 ^b	290 ^c	297 ^c	8.0
GF	1.01 ^b	.84 ^a	.89 ^a	.87 ^a	.96 ^b	.98 ^b	.03
Phase 3, d 16-27							
	NC.55/	.50/	.50/	.55/	.55/	PC .55/	
SID Ile & Val:Lys	.67	.62	.67	.62	.67	.67	SEM
ADG	477 ^{cd}	397 ^a	441 ^b	396 ^a	454 ^{bc}	501 ^d	10.3
GF	.77	.82	.77	.77	.77	.81	.02

^{abcd} ($P < .01$).

Key Words: isoleucine, pigs, valine

210 Nutrient analysis of sorghum dried distillers grains with solubles from ethanol plants located in the western plains region.

K. M. Sotak,* R. D. Goodband, M. D. Tokach, J. M. DeRouchey, S. S. Dritz, and J. L. Nelssen, *Kansas State University, Manhattan.*

Samples of sorghum dried distillers grains with solubles (DDGS) were collected and analyzed to establish a nutrient database and evaluate the quality and consistency between and within 5 ethanol plants in the Western Plains region. Four plants were located in Kansas and 1 in Texas. Four plants contributed 4 samples each and 1 plant contributed 5 samples from different manufacturing lots of DDGS. Each sample was analyzed for AA, DM, CP, crude fiber, crude fat, ash, NDF, ADF, Ca, P, trace minerals, GE, and starch. In addition, DE (Ewan, 1989), ME, and NE (Noblet and Perez, 1993) were calculated from the nutrient analysis. Of the 5 plants, 3 produced pure sorghum DDGS samples while 2 produced mixed sorghum and corn DDGS samples, with sorghum representing 60 or 70% of the DDGS. For the pure sorghum DDGS, the overall sample average means for each nutrient and SD on a DM basis were: DM (89.5%, 0.96), CP (34.2%, 3.78), crude fat (10.5%, 1.10), ash (4.4%, 0.83), NFE (40.3%, 3.47), crude fiber (10.6%, 1.48), ADF (26.4%, 4.96), NDF (35.1%, 5.34), starch (4.3%, 0.72), calculated DE (3,439 kcal/kg), calculated ME (3,206 kcal/kg), calculated NE (2,025 kcal/kg), Ile (1.37%, 0.14), Leu (3.84%, 0.63), Lys (0.88%, 0.06), Met (0.55%, 0.13), Thr (1.04%, 0.09), Trp (0.26%, 0.02), Val (1.67%, 0.15), Ca (0.01%, 0.2), and P (0.72%, 0.20). Mean particle size was $670 \pm 186 \mu$. The mixed sorghum and corn DDGS samples' means and SD on a DM basis were: DM (90.27%, 0.30), CP (32.69%, 1.34), crude fat (11.30%, 0.40), NFE (40.63%, 1.82), crude fiber (11.30%, 0.68), ADF (22.07%, 2.28), NDF (36.73%, 1.46), calculated DE (3245 kcal/kg), calculated ME (3044 kcal/kg), calculated NE (1988 kcal/kg), Lys (0.87%, 0.03), Met (0.55%, 0.16), Thr (1.05%, 0.04), Trp (0.24%, 0.01), and P (0.74%, 0.07). The standard deviations among sorghum DDGS plants were similar to that within plants for most nutrients. Results of these analyses can be used by nutritionists to better utilize sorghum DDGS in swine diets.

Key Words: dried distillers grains with solubles, nutrient analysis, sorghum

211 Vomitoxin concentration in nursery pig diets and effectiveness of commercial products to mitigate its effects.

J. A. Barnes,* J. M. DeRouchey, M. D. Tokach, R. D. Goodband, S. S. Dritz, J. M. Nelssen, and E. Hansen, *Kansas State University, Manhattan.*

A total of 180 pigs (10.4 kg BW; 34 d of age) were used in a 21-d trial to evaluate the effects of vomitoxin concentration in nursery diets and

effectiveness of commercial products to mitigate vomitoxin's negative effects on performance. Treatments were arranged in a completely randomized design with 6 pigs/pen and 6 pens/treatment. All diets included 17% dried distillers grains with solubles (DDGS). Pens of pigs were allotted to 1 of 5 treatments, of a control (PC) diet with corn-soybean meal and low vomitoxin (0.8 ppm) DDGS, a negative control (NC) containing 4 ppm dietary vomitoxin from contaminated DDGS (12 ppm), and the negative control with 0.1% Biofix Plus (B, ADM Alliance Nutrition; Quincy, IL, USA), 0.15% Cel-can (Value-Added Science & Technologies; Mason City, IA, USA) plus 0.5% bentonite clay (C), or 0.25% Defusion Plus (D, North American Nutrition Co., Inc.; Brookville, OH, USA). All diets tested at or below cautionary levels for Fumonisin B1 and Zearelenone. From d 0 to 10, pigs fed the NC, B, C or D had poorer ($P < 0.05$) ADG and ADFI than pigs fed the PC. Pigs fed the PC diet had improved G:F ($P < 0.05$) compared with pigs fed the NC, B, or C with pigs fed diets containing D being intermediate. For the total experimental period, pigs fed the PC diet had greater ($P < 0.05$) ADG, ADFI, and final BW than pigs fed any 4 ppm vomitoxin-contaminated diet. Pigs fed D had greater ADG ($P < 0.05$) than pigs fed the NC diet or diets containing B, or C. Pigs fed the PC diet had improved G:F ($P < 0.05$) compared with the NC, B, or C, while pigs fed D had greater G:F ($P < 0.05$) than pigs fed the NC. While no mitigation product in a diet with 4 ppm vomitoxin restored performance to the PC diet, Defusion Plus improved performance over the NC diet.

Table 1. Effects of vomitoxin and commercial products on nursery pig performance

	Positive Control (PC)	Negative Control (NC)	Biofix Plus (B)	Cel-can + bentonite clay (C)	Defusion Plus (D)	SEM
d 0 to 10						
ADG, g	487 ^a	313 ^b	305 ^b	316 ^b	324 ^b	17.8
ADFI, g	709 ^a	522 ^b	512 ^b	518 ^b	502 ^b	23.8
G:F	0.69 ^a	0.60 ^b	0.60 ^b	0.61 ^b	0.65 ^{ab}	0.019
d 0 to 21						
ADG, g	585 ^a	419 ^c	409 ^c	418 ^c	469 ^b	14.9
ADFI, g	895 ^a	719 ^b	687 ^b	699 ^b	739 ^b	29.6
G:F	0.66 ^a	0.59 ^c	0.60 ^{bc}	0.60 ^{bc}	0.64 ^{ab}	0.016
Final BW, kg	22.6 ^a	19.2 ^c	19.0 ^c	19.2 ^c	20.4 ^b	0.40

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

Key Words: pig, vomitoxin, mycotoxin

212 Effect of dietary leucine and isoleucine levels on amino acid serum concentration and expression of an intestinal amino acid transporter in pigs.

V. Méndez¹, A. Morales¹, M. Cervantes*¹, A. B. Araiza¹, M. Barrera², and D. González¹, ¹ICA, Universidad Autónoma de Baja California, Mexicali, Baja California, México, ²Universidad Autónoma de Sonora, Hermosillo, Son, México.

Branched chain (BC) amino acids (AA; Leu, Ile, and Val) share at least one intestinal transporter for absorption. So, the dietary content of one may affect the intestinal absorption of the other AA. These AA, especially Leu, is recognized as an activator of mTOR, the protein synthesis regulator in muscle cells. An experiment was conducted to determine if adding Leu and Ile to a lysine-fortified diet affects the expression of the jejunal AA transporter (B0) mRNA, and the serum

concentration of indispensable AA. Sixteen crossbred pigs (Landrace-Ham-Duroc; BW of 15.9 ± 0.6 kg) were used. Treatments (T) were: T1, basal wheat-based diet fortified with crystalline Lys, Thr, and Met; T2, plus 0.50% Leu; T3, plus 0.50% Ile; and T4, plus 0.50% Leu and 0.50% Ile. All diets were added with vitamins and trace minerals. At the end of a 28-d trial, all pigs were sacrificed and blood was collected to analyze serum content of AA; jejunum samples were also collected to analyze the expression of B0 mRNA. The effects of Leu, Ile, and their interaction were tested. Also, 3 contrasts were constructed to analyze the effect of the single or combined AA addition. The relative expression results (arbitrary units: ratios of B0 mRNA molecules:18S rRNA molecules) were: 1.69, 0.208, 0.552, 0.357, for T1 to T4, respectively. Leu and Ile, alone or in combination, increased ($P < 0.01$) the expression of B0 mRNA. Serum AA concentration ($\mu\text{Mol/ml}$) was: Arg, 0.29, 0.33, 0.24, 0.27; Ile, 0.17, 0.07, 0.98, 0.46; Leu, 0.18, 0.40, 0.13, 0.47; Lys, 0.84, 0.51, 0.63, 0.60; Met, 0.09, 0.09, 0.07, 0.08; Phe, 0.16, 0.17, 0.14, 0.24; Thr, 1.18, 0.76, 0.57, 0.91; Val, 0.15, 0.15, 0.14, 0.23, for T1 to T4, respectively. Leu alone increased Leu and Val, but decreased Ile and Phe serum concentration ($P < 0.01$). Ile alone increased Ile, but decreased Thr concentration. Addition of Leu and Ile decreased Thr but increased Val serum content. These data indicate that dietary Leu and Ile may affect the AA availability for protein synthesis and the growth of pigs.

Key Words: swine, leucine, isoleucine, amino acid transport

213 Effects of diet change and digestibility of corn distillers dried grains with solubles (DDGS) on growth performance and carcass characteristics of growing-finishing pigs. A. M. Hilbrands^{1,2}, L. J. Johnston^{1,2}, G. C. Shurson¹, S. K. Baidoo^{1,3}, and L. W. O. Souza¹, ¹University of Minnesota, St. Paul, ²West Central Research and Outreach Center, Morris, MN, ³Southern Research and Outreach Center, Waseca, MN.

Efficacy of diets containing 40% DDGS to growing-finishing pigs and the accuracy of Standardized Ileal Digestible (SID) AA estimates for DDGS sources when fed continuously or intermittently has not been studied. Crossbred pigs ($n = 324$, BW = 33.2 ± 3.0 kg) were blocked by BW, and pens within a block were assigned randomly to 1 of 6 dietary treatments (6 pens/treatment; 9 pigs/pen). Diets were formulated on a SID AA basis and were similar in ME content. Treatments included: a corn-soybean meal control (CON), CON + 40% low AA digestibility DDGS (0.41% SID Lys; Lo), CON + 40% high AA digestibility DDGS (0.67% SID Lys; Hi), alternating between Lo and CON (Lo-CON), Hi and CON (Hi-CON), and Hi and Lo (Hi-Lo). Digestibility of AA in DDGS sources was determined in a previous study. Diet switches coincided with phase changes. Pigs were harvested after 98 d on feed. Average daily gain was reduced ($P < 0.05$) for pigs fed Lo and Hi-Lo and tended ($P < 0.10$) to be reduced in Hi compared with CON. Pigs fed Lo tended to have decreased ADFI compared with CON ($P < 0.10$). Daily lean gain was reduced for Lo and Hi-Lo pigs compared with CON ($P < 0.05$). Dressing percentage was lower for Lo and Hi-Lo pigs compared with CON ($P < 0.05$). Pigs fed Lo-CON and Hi-CON were not affected by treatment. Results suggest that pigs continuously fed a diet containing 40% low digestible AA DDGS experience reduced ADG, ADFI and lean gain compared with pigs continuously or intermittently consuming a control diet. Regardless of predicted digestible AA of the DDGS, periodic inclusion and removal of 40% DDGS from diets did not adversely affect growth or carcass traits.

Table 1.

Trait	CON	Lo-CON	Hi-CON	Lo	Hi	Hi-Lo	SEM
Final BW, kg	121.5 ^{abx}	121.6 ^{abx}	123.0 ^a	115.9 ^c	118.3 ^{bcy}	117.8 ^c	1.1
ADG, kg	0.92 ^{abx}	0.92 ^{abx}	0.93 ^a	0.86 ^c	0.89 ^{bcy}	0.88 ^c	0.0001
ADFI, kg	2.70 ^x	2.72 ^a	2.78 ^a	2.57 ^{by}	2.73	2.68	0.002
Lean gain/d, g	395 ^{ab}	396 ^{ab}	404 ^a	362 ^d	383 ^{bc}	367 ^{cd}	34.1
Carcass lean, %	51.8	52.1	52.1	51.3	52.3	50.8	0.326
Dressing percent	76.2 ^a	75.8 ^{ab}	76.0 ^{abx}	74.7 ^c	75.1 ^{bcy}	74.6 ^c	0.076

^{abcd}Means with unlike superscripts differ ($P < 0.05$). ^{xy}Means with unlike superscripts tend to differ ($P < 0.10$).

Key Words: DDGS, diet changes, digestibility, pigs

214 Nutrient digestibility and performance of weaned pigs fed soybean meal processed using fermentation or extrusion. J. D. Lee,* J. P. Holt, and K. W. Tudor, *Illinois State University, Normal.*

Subjecting solvent-extracted soybean meal (SBM) to additional processing methods or adding enzymes at mixing may reduce residual anti-nutritional factors, resulting in increased pig performance. Two experiments were conducted to determine the effects of replacing SBM with processed SBM on the performance of weaned pigs. Fermented SBM was processed in our lab by submerged, aerobic fermentation using *Saccharomyces cerevisiae*. Fermentation resulted in undetectable levels of phytic acid, raffinose and stachyose. Barrows ($n = 36$, BW 8.4 kg) were placed in metabolism crates and allotted to one of 4 dietary treatments containing either; conventional SBM (CON), heated SBM (HTD), fermented SBM (FSBM), or SBM + phytase (PHY). Barrows were adapted to diets for 7d with 3d of total urine and fecal collection. Feed, feces and urine were analyzed for GE using bomb calorimetry and N using the combustion method. A 28d growth assay was then conducted with 336 weaned pigs (BW 6.23 kg) blocked by weight and sex, and randomly assigned to 48 pens. Pigs were fed a standard nursery diet containing either; SBM (CON), extruded soybeans (EXT), 7% of a commercially available solid-state fermented SBM (PSG), or SBM + phytase (PHY). Experimental diets were fed in 3 phases. Pig weights and feed disappearance were measured weekly and used to calculate ADG, ADFI, and G:F. There were no differences ($P > 0.05$) in DM and N digestibility or ME of pigs fed experimental diets. DE tended to be lower ($P = 0.08$) for pigs fed FSBM (67.0%) when compared with pigs fed CON (73.0%), HTD (76.0%), and PHY (70.0%). Pigs fed EXT had lower ($P < 0.05$) overall ADG (0.22 kg/d) compared with pigs fed CON (0.32), PSG (0.32) and PHY (0.29). ADFI was lower ($P < 0.05$) for pigs fed EXT (0.37 kg/d) compared with pigs fed CON (0.48), PSG (0.50) and PHY (0.46). Additional processing of SBM did not impact nutrient digestibility in pigs. An optimal temperature may not have been reached when extruding soybeans. PSG can be used as a partial replacement for conventional SBM in weaned pig diets.

Key Words: fermented soybean meal, extrusion, swine

215 The effects of different types of soybean meal on ileal amino acid digestibility of weaning pigs. D. H. Kim,* P. S. Heo, and Y. Y. Kim, *School of Agricultural Biotechnology, Seoul, Korea.*

The apparent (AID) and standardized (SID) ileal digestibility of amino acids in different types of soybean meal were evaluated. A total of 14 weanling barrows with an average body weight of 6.54 ± 0.34 kg, fitted with T-cannula at the distal ileum were given a diet containing various types of soy products. The dietary treatments were: 1) SBM: soybean meal, 2) FSBMA: fermented soybean meal with *Aspergillus oryzae* GB-107, 3) FSBMB: fermented soybean meal with *Bacillus subtilis* PP6, 4) UVSBM: UV sterilized fermented soybean meal with *Bacillus subtilis* PP6, 5) SPC: soy protein concentrate, and 6) ESBM: enzyme-supplemented soybean meal. The soy products were included in diets with the same level of crude protein and other nutrients. All diets contained chromic oxide as the indigestible marker and N-free diet was used for calculating endogenous amino acid losses. The AID of Ile, Val, and Tyr was higher ($P < 0.05$) in the FSBMB treatment compared with the FSBMA treatment. Additionally, the AID of Phe was lower ($P < 0.05$) in the FSBMA treatment compared with the FSBMB and SPC treatments. Supplementation of the soy product fermented by *Aspergillus oryzae* (FSBMA) also resulted in inferior ($P < 0.05$) SID of Ile and Val compared with the FSBMB treatment. Also, the SID of Phe was lower ($P < 0.05$) in the FSBMB treatment relative to the SBM, FSBMA, UVSBM, and SPC treatments. In case of Tyr, the FSBMB treatment showed superior SID ($P < 0.05$) compared with the SBM, FSBMA, and ESBM treatments. The present data demonstrated that the nutrient digestibility of fermented soy varied according to the fermenting microbes utilized.

Key Words: soybean meal, piglets, Ileal amino acid digestibility

216 Supplementation of lysine, threonine, methionine, and leucine in wheat-based diets on serum concentration of GH and IGF-1 in growing pigs. K. Minero, A. Morales,* H. García, E. Avelar, M. Cervantes, and B. A. Araiza, *ICA, Universidad Autónoma de Baja California, Mexicali, Baja California, México.*

Insulin-like growth factor 1 (IGF-1), which is produced mainly in liver in response to the growth hormone (GH) effect, is known to function as regulator of protein synthesis in muscle. Lys, Thr, and Met are the first 3 limiting AA in wheat; also, Lys and Leu have been shown to affect the concentration of IGF-1 in cell culture. Thus, an experiment was conducted to determine if supplemental Lys, Thr, Met, and Leu in wheat-based diets affects the concentration of IGF-1 and GH in serum of growing pigs. Twenty crossbred pigs (Landrace-Ham-Duroc; initial BW of 14.9 ± 0.27 kg) were used in a Randomized Complete Block design. Treatments (T) were: T1, basal wheat-based diet, 0.38% Lys, 0.37% Thr, 0.21% Met, 0.86% Leu; T2, as T1 plus 0.70% Lys, 0.24% Thr, and 0.10% Met (LTM); T3, as in T2, but added with 0.80% Leu (LTM+Leu); T4, positive control, wheat-soybean meal diet (PC). The basal diet was deficient in Lys and Thr, marginal in Met, but sufficient in the remaining indispensable AA. Crystalline Lys, Thr, and Met in T2 and T3 were added at levels similar to those in T4. The PC diet was formulated to meet the requirement of Lys; therefore it was sufficient in His, Ile, Trp, and Val, but contained substantial excesses of Leu, Arg, and Phe. At the end of a 28-d trial, all pigs were sacrificed and blood was collected to analyze the serum concentration of GH and IGF-1. The effects of supplemental LTM, and Leu were tested. The concentration of GH and IGF-1 in serum (ng/ml) was: GH, 14.8, 12.6, 18.0, 13.0; IGF-1, 17.9, 20.0, 22.6, 22.1, for T1 to T4, respectively. Supplementation of LTM did not affect GH ($P = 0.166$), but increased IGF-1 ($P = 0.040$). Leu addition to the LTM diet (T3), as compared with the LTM diet (T2) increased GH ($P = 0.003$) and IGF-1 ($P = 0.002$) concentration. Pigs fed the PC diet had higher IGF-1 concentration ($P = 0.001$) than those fed the LTM diet; there was no difference

in GH ($P = 0.114$). These data show a marked effect of Leu on GH and IGF-1 serum concentration, and indicate a relationship between Leu and the GH-IGF-1 axis. These also indicate that Lys, Thr, and Met, alone or in combination, might affect the synthesis of protein through the IGF-1 signaling pathway in growing pigs.

Key Words: swine, leucine, lysine, GH-IGF-1 axis

217 The effects of increasing threonine to lysine ratio on growth and carcass characteristics of 83 to 117 kg pigs fed ractopamine. J. W. Bundy*¹, P. S. Miller¹, R. L. Payne², T. E. Burkey¹, E. E. Hinkle¹, and H. Tran¹, ¹University of Nebraska, Lincoln, ²Evonik-Degussa Corporation, Kennesaw, GA.

Sixty-three barrows (Danbred \times NE whiteline; initial BW = 83.5 kg) were used to investigate the effects of increasing the Thr to Lys ratio of diets with ractopamine (RAC) on growth and carcass characteristics. Pigs were individually penned in an environmentally-controlled room. Each pig was randomly assigned to 1 of 7 dietary treatments in a completely-randomized design. All diets were corn-soybean meal based. One dietary treatment was formulated to contain adequate Lys (0.71% SID) with 10 ppm RAC. The remaining 6 diets were formulated to 0.62% SID Lys, slightly below the estimated Lys requirement previously obtained. One of the Lys deficient diets was formulated to 0.67 Thr:Lys as suggested by the NRC (1998) with no RAC inclusion. The remaining 5 Lys deficient diets were formulated with increasing Thr concentrations from 0.57 to 0.77 SID Thr:Lys and 10 ppm RAC. Other limiting AA were maintained at constant ratios relative to Lys. Pigs and feeders were weighed weekly to estimate ADG, ADFI, and G:F. After the 4 wk feeding period, pigs were harvested in a commercial facility and carcass data were collected. No differences were observed for ADFI. Pigs fed the adequate Lys diet consumed more Lys (29 vs 26 g/d; $P < 0.01$) than the Lys deficient diet formulated with similar AA:Lys. Daily Thr intake increased linearly ($P < 0.01$) as Thr level increased. Pigs fed the diet without RAC had decreased ($P < 0.05$) ADG and G:F compared with pigs fed the similar diet with 10 ppm RAC (1.05 vs 1.20 kg; 0.30 vs 0.33 kg/kg, respectively). Feed efficiency increased linearly ($P < 0.05$) among treatments as Thr:Lys increased. There was a tendency for a quadratic response ($P < 0.06$) in carcass lean percentage and loin depth as Thr:Lys levels increased. Carcass jowl iodine value increased linearly (67.4 to 69.4; $P < 0.05$) as Thr concentration increased. In conclusion, increasing the SID Thr:Lys of RAC containing diets for finishing pigs increased G:F, carcass percent lean, loin depth, and jowl iodine value at levels up to 0.77 SID Thr:Lys.

Key Words: ideal protein, lysine, ractopamine, threonine

218 Effects of dietary inclusion level of two corn co-products [distillers dried grains with solubles (DDGS) and high-protein distillers dried grains (HP-DDG)] on the growth performance and carcass characteristics of wean-to-finish pigs. A. Rojo*¹, C. L. Puls¹, M. Ellis¹, A. M. Gaines², B. A. Peterson², B. F. Wolter², M. Kocher², and C. M. Peterson², ¹University of Illinois, Urbana, ²The Maschhoffs, Carlyle, IL.

The objective of this experiment was to evaluate the combined effect of dietary levels of DDGS and HP-DDG on wean-to-finish pig growth performance, and carcass and pork quality characteristics. A RCBD was used with a 3×4 factorial arrangement of dietary treatments: 1) DDGS level (0, 15 and 30%), and 2) HP-DDG level (0, 10, 20 and 30%). Diets

were formulated to meet or exceed NRC (1998) recommendations. Six replicates with a total of 2,448 pigs, housed in mixed-gender pens (barrows and gilts) of 34 were used. The growth evaluation was carried out from weaning (5.9 ± 0.10 kg) to wk 20 post-weaning (107.6 ± 6.86 kg); pigs were sent for harvest when the mean pen BW was 123.8 ± 1.48 kg to a commercial plant where carcass measurements were taken. A subsample of 2 barrows and 1 gilt from each pen were selected for belly and loin quality evaluation. There were treatment interactions ($P \leq 0.05$) for ADG and ADFI. For the 0% HP-DDG diet, there was no effect of DDGS inclusion level on ADG or ADFI, however, for other HP-DDG inclusion levels, ADG and ADFI were linearly reduced with increasing DDGS level with the magnitude of the reduction increasing with HP-DDG inclusion level. There was no effect ($P \geq 0.05$) of either HP-DDG or DDGS inclusion level on G:F. Increasing the dietary level of both HP-DDG and DDGS was associated with linear reductions ($P \leq 0.05$) in carcass yield, *Longissimus* muscle depth and backfat depth, and belly flop distance. These results suggest that DDGS can be included at up to 30% in diets (without HP-DDG) without compromising growth performance of wean-to-finish pigs. However, growth performance was increasingly compromised at higher inclusion levels of both co-products and belly firmness was negatively affected by increasing levels of both DDGS and HP-DDG.

Key Words: DDGS, growth, high protein DDG, pigs

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

Two digestibility studies were carried out to evaluate the effect of particle size (PS) reduction on the digestibility of energy of a range of DDGS samples. Study 1 used one sample of DDGS with an initial mean PS of 1,557 μm that was ground through a hammer mill to PS's of 1,180, 890, 560 and 351 μm . Study 2 used 15 DDGS samples from different sources selected to represent the variation in PS currently available to the industry. The mean PS was 716 ± 264.0 μm (range = 497 to 1,557 μm), and this was reduced by grinding each DDGS source through a hammer mill to an average of 344 ± 36.0 μm (range = 285 to 403 μm). A standard digestibility assay was used in both studies consisting of 4-d adaptation and 3-d collection periods. A corn based control diet (89.5% corn ground to 500 μm PS, 7.9% casein, 1.0% limestone, 0.65 dicalcium phosphate, 0.40 salt, 0.45 vitamins and microminerals, and 0.10% chromic oxide) was used in both studies; experimental diets were created by substituting 50.4% of the corn with the respective DDGS sample. A total of 34 barrows (initial BW 17.2 ± 0.9 kg) were used in an incomplete block design, with a total of 36 and 8 pigs being fed the control and DDGS diets, respectively. In Study 1, there was no effect ($P \geq 0.05$) of reducing PS on either energy digestibility or DE and ME content. In Study 2, reduction of PS increased ($P \leq 0.05$) the digestibility of energy, and DE and ME content by an average of 2.7 percentage units, and 136 and 141 kcal/kg DM, respectively; however, the range in improvement for individual samples varied from 1.0 to 4.8 percentage units for energy digestibility, and between 50 and 240 and 43 and 252 kcal/kg DM for DE and ME, respectively. The results of this research suggest that PS reduction has a variable effect on the digestibility of energy of DDGS. Further research is required to understand the causes of the variable relationship between PS and energy digestibility between and within DDGS samples.

Key Words: DDGS, energy, particle size

220 Evaluation of SID lysine level, replacement of fish meal with crystalline amino acids, and lysine:CP ratio on growth performance of nursery pigs from 6.8 to 11.3 kg. J. E. Nemecek,^{*} M. D. Tokach, S. S. Dritz, R. D. Goodband, J. M. DeRouchey, and J. L. Nelssen, *Kansas State University, Manhattan.*

Three 14-d experiments were used to evaluate SID Lys level, the replacement of fish meal with crystalline AA, and Lys:CP ratio on growth performance of nursery pigs from 6.8 to 11.3 kg. All diets were corn-soybean meal-based containing 10% dried whey and were in meal form. For all trials, on d 3 after weaning, pigs were allotted to 1 of 6 dietary treatments using a completely randomized design. In Exp 1, 294 nursery pigs (PIC TR4 \times 1050, initially 6.8 kg) were allotted with 7 pens per treatment and 7 pigs per pen. Diets were blended to achieve SID Lys levels of 1.15, 1.23, 1.30, 1.38, 1.45, and 1.53%. As SID Lys increased, ADG (290, 306, 342, 328, 330, 284 g) and ADFI (388, 394, 435, 396, 398, 336 g) increased (quadratic; $P < 0.002$) with a plateau at 1.30%. As lysine increased, G:F (0.74, 0.78, 0.79, 0.83, 0.83, 0.85) also improved (linear; $P < 0.0001$). A total of 282 nursery pigs were used in Exp. 2 and 3 each (initially 7.3 and 6.9 kg, respectively) with 7 pens per treatment (5 reps with 7 pigs and 2 reps with 6 pigs). In Exp. 2, all diets contained 1.30% SID lysine, and fish meal was included at 4.50, 3.60, 2.70, 1.80, 0.90, or 0.00%. Crystalline Lys, Met, Thr, Trp, Ile, and Val replaced fish meal while maintaining minimum AA ratios. Glutamine and glycine were also added to diets to maintain a maximum Lys:CP ratio of 7.0 or less. There was no difference ($P > 0.29$) in ADG (376, 372, 389, 378, 380, 380 g), ADFI (528, 517, 537, 525, 531, 546 g), or G:F (0.71, 0.72, 0.73, 0.72, 0.72, 0.70) as fish meal decreased and crystalline AA increased. In Exp. 3, the Lys:CP ratios tested were 6.79, 6.92, 7.06, 7.20, 7.35, and 7.51%. SID lysine was 1.3% and fish meal was adjusted as a source of non-essential N to achieve the Lys:CP ratios. Both ADG (347, 358, 358, 356, 387, 336 g) and G:F (0.73, 0.71, 0.72, 0.73, 0.73, 0.68 g) tended to improve (quadratic, $P < 0.09$) as Lys:CP ratio increased from 6.79 to 7.35% with decreased performance in the pigs fed the highest Lys:CP ratio. These trials indicate that crystalline amino acids can replace fish meal in diets for 6.8 to 11.3 kg pigs and that the diet should contain at least 1.3% SID Lys and a maximum total Lys:CP ratio of 7.35%.

Key Words: amino acid, fish meal, nursery pig

221 Standardized ileal amino acid digestibility of high protein distillers dried grains with or without solubles for laying hens, turkey poults and broiler chicks. P. M. Banks,^{*} T. J. Applegate, and O. Adeola, *Purdue University, West Lafayette, IN.*

Three studies were conducted to determine standardized ileal digestibility (SID) of amino acids (AA) in high protein distillers dried grains (HP-DDG), high protein distillers dried grains with solubles (HP-DDGS) and a freeze-dried blend (FDB) of HP-DDG and condensed distillers' solubles (CDS) in laying hens, turkey poults and broiler chicks. On DM basis, the test ingredients contained 60, 55, 57% CP; 1.9, 3.1, 3.9% Fat; 43, 32, 34% NDF and 27, 18, 25% ADF for HP-DDG, HP-DDGS and FDB, respectively. Semi-purified diets, with test ingredient as the only source of protein, were fed to 16 replicate cages, of 2 birds in the hen study or 12 replicate cages of 8 birds for the poult and broiler studies. In the hen study, 4 replicate cages were pooled ($n = 4$), and SID of Lys was 33, 39 and 40%, SID of Met was 72, 69 and 76%, SID of Trp was 74, 82 and 81% and SID of Thr was 57, 56 and 62% for HP-DDG, HP-DDGS and FDB, respectively. Of the indispensable AA, only Met and Trp SID were significantly different between ingredients. The SID of Met was lower ($P < 0.05$) in

HP-DDGS than in FDB, but HP-DDG was not different ($P > 0.05$) than either FDB or HP-DDGS. The SID of Trp was lower ($P < 0.05$) in HP-DDG than in HP-DDGS, but FDB was not different ($P > 0.05$) than either HP-DDG or HP-DDGS. In the poult and broiler studies, 2 replicate cages were pooled ($n = 6$). The SID of Lys was 52, 63 and 58%, SID of Met was 82, 86 and 87%, SID of Trp was 71, 79 and 78% and SID of Thr was 61, 70 and 69% for HP-DDG, HP-DDGS and FDB, respectively for poults. Of the indispensable AA, the SID of Trp was significantly different between ingredients, with HP-DDG being lower ($P < 0.05$) than both FDB and HP-DDGS. The SID of Lys was 58, 56 and 56%, SID of Met was 83, 79 and 82%, SID of Trp was 71, 73 and 72% and SID of Thr was 64, 59 and 62% for HP-DDG, HP-DDGs and FDB, respectively for chicks. The SID of indispensable AA was not significantly different between ingredients for chicks. The inclusion of CDS (HP-DDG vs. HP-DDGS) led to 3% units higher SID of sum of all AA for poults but decreased 2 and 5% units for hens and chicks, respectively. Heat, as the drying method (HP-DDGS vs. FDB), decreased SID of sum of all AA by 3, 4 and 6% units for poults, chicks and hens, respectively.

Key Words: amino acid digestibility, high-protein DDG(s), poultry

222 Replacing conventional soybean meal with low-oligosaccharide soybean meal has minimal effect on early piglet performance. D. Pangeni,* J. A. Jendza, L. Anil, and S. K. Baidoo, *University of Minnesota, Southern Research and Outreach Center, Waseca.*

A trial was conducted to determine the effect of replacing conventional soybean meal (SBM) with low oligosaccharide soybean meal (LOSBM) on growth performance and carcass characteristics of pigs from wean to finish. The lower fiber content of LOSBM increases the CP content, so the interaction between LOSBM and the use of fishmeal and spray dried plasma (FM/SDP) was also evaluated. There were 9 pigs per pen, 6 treatments, and 8 blocks. The 432 pigs were assigned to pens in a randomized complete block design by body weight. Treatments were fed in 6 phases and based on a 2×3 factorial arrangement with 2 levels of FM/SDP (none or phases 1 to 3) and 3 levels of LOSBM inclusion (none, phases 1 to 3, or phases 1 to 6). Body weights and feed intake were recorded at the beginning and end of each phase, pigs were slaughtered at an average BW of 115kg, and carcass characteristics were measured. There was no interaction between FM/SDP in the nursery and LOSBM in any phase for ADG, ADFI or G:F. Average daily gain was not affected by LOSBM in any phase, but was improved by FM/SDP in phase 2 ($P < 0.01$). Feed intake was reduced only in phase 5 by LOSBM ($P < 0.05$), was not affected by FM/SDP. Feed efficiency was improved by replacing SBM with LOSBM in phases 1 and 2 ($P < 0.01$) and by the inclusion of FM/SDP in phase 2 ($P < 0.05$). However these gains did not persist into the later phases and did not affect overall performance at market weight. Neither treatment factor affected live weight, carcass weight, fat or loin depth, percent lean, percent yield, grade or value. In conclusion, using LOSBM instead of conventional SBM results in minor gains in piglet feed efficiency by way of reduced feed intake, and piglets fed FM/SDP only had slightly improved ADG. These early improvements do not affect overall performance from wean to finish, nor do they affect the final carcass.

Key Words: low-oligosaccharide, soybean meal, swine, wean to finish

223 Effect of increasing concentrations of two thermal stable strains of beta-mannanase in corn-soybean meal diets on grower pig performance. Z. Rambo*¹, J. Ferrel², D. Anderson², D. Kelly¹, and B. Richert¹, ¹Purdue University, West Lafayette, IN, ²ChemGen Corp., Gaithersburg, MD.

Two-hundred 20 8 pigs (initial weight = 50.9 kg \pm 0.38) were used to evaluate the effect of 2 strains of thermal stable β -mannanase enzyme (HTs1 and HTs2), titrated at 2 or 3 concentrations, in a corn-soybean meal diet on pig growth, feed efficiency, and overall performance during the grower period. Pigs were allocated in a randomized complete block design of mixed gender pens, stratified by litter and initial BW to 6 treatments, with 8 pens/treatment. Dietary treatments were: Negative Control (T1; corn-soybean meal+ 0.5% supplemental fat), T1 plus enzymes for treatments T2 (HTs2, 0.02 MU/kg), T3 (HTs2, 0.04 MU/kg), T4 (HTs2, 0.06 MU/kg), T5 (HTs1, 0.04 MU/kg), T6 (HTs1, 0.06 MU/kg). Pigs were fed 3 dietary phases, each 2 weeks in duration. Individual BW and pen feed disappearance were recorded at the end of each period. Phase 1 ADG linearly increased (899, 915, 942, 976, 929, 973 g/d, treatments 1–6 respectively) with increasing concentrations of HTs1 ($P < 0.02$) and HTs2 ($P < 0.03$) inclusion. ADFI increased (linear, $P < 0.03$) with increasing concentrations of HTs2. G:F tended to increase (linear, $P < 0.12$) with increasing concentrations of HTs1. Phase 2 ADFI (quadratic, $P < 0.07$) and G:F (quadratic, $P < 0.15$) tended to improve with increasing concentration of HTs2. Phase 3 ADFI tended to decrease and then increase (quadratic, $P < 0.13$) to increasing concentrations of HTs1 and HTs2. Overall, inclusion of HTs1 or HTs2 only numerically improved ADG (2.6%; $P > 0.17$), ADFI (1.3%; $P > 0.25$), and G:F (1%; $P > 0.56$). Early responses to the enzymes during phase 1 are promising in improving gain and efficiency; however, additional work is needed to precisely define the enzyme response surface. These data demonstrate no significant difference in the performance response between 2 thermal stable strains of β -mannanase enzymes.

Key Words: swine, beta-mannanase, thermal stable

224 Effect of increasing concentrations of two thermal stable strains of beta-mannanase in corn-soybean meal diets on nursery pig performance. Z. Rambo*¹, J. Ferrel², D. Anderson², D. Kelly¹, and B. Richert¹, ¹Purdue University, West Lafayette, IN, ²ChemGen Corp., Gaithersburg, MD.

Two-hundred 10 pigs (initial BW = 6.11 \pm 0.06 kg; 20 d of age) were used to evaluate the effect of 2 strains of thermal stable β -mannanase enzymes (HTs1 and HTs2), titrated at 3 concentrations in a corn-soybean meal based diets on pig growth, feed efficiency, and overall performance during the nursery period. Pigs were allocated in a randomized complete block design of mixed gender pens, stratified by litter and initial BW to 7 treatments, with 7 pens/treatment. Dietary treatments were: Negative Control (T1; 3.5, 1.0, and 1.0% added fat phase 1, 2, and 3, respectively), T1 plus enzymes for treatments T2 (HTs2, 0.02 MU/kg), T3 (HTs2, 0.04 MU/kg), T4 (HTs2, 0.06 MU/kg), T5 (HTs1, 0.02 MU/kg), T6 (HTs1, 0.04 MU/kg), T7 (HTs1, 0.06 MU/kg). Pigs were fed 3 dietary phases, phase 1 (d 0 to 7), phase 2 (d 7 to 21), phase 3 (d 21 to 35). Individual BW and pen feed disappearance were recorded weekly. Phase 1 G:F tended to decrease (linear, $P < 0.09$) with increasing concentrations of HTs2. Phase 2 ADG tended to increase (linear, $P < 0.09$) with increasing concentrations of HTs1 and G:F increased (linear, $P < 0.02$) with increasing concentrations of HTs2 and HTs1. Overall, inclusion of HTs2 significantly improved G:F (quadratic, $P < 0.04$) while HTs1 tended to improve G:F (linear, P

< 0.09) (0.628, 0.662, 0.652, 0.639, 0.624, 0.650, 0.648 ± 0.011; treatments 1–7, respectively). Numerical increases in ADG for phase 3 ($P > 0.27$) and Overall (410, 443, 434, 420, 402, 430, 430 ± 14 g/d; $P > 0.17$) above T1 were observed for each enzyme. While additional work is needed to precisely define the response surface in relation to dietary composition, the improvements in G:F and numerical gain improvements are promising. These data also demonstrate no significant difference in the nursery pig performance response between the 2 thermal stable strains of β -mannanase enzyme.

Key Words: beta-mannanase, thermal stable, swine, growth

225 Standardized total tract digestibility of P in blood products fed to weanling pigs. F. N. Almeida* and H. H. Stein, *University of Illinois, Urbana.*

An experiment was conducted to measure the apparent (ATTD) and the standardized (STTD) total tract digestibility of P in spray dried plasma protein (SDPP), in porcine blood meal, and in avian blood meal when fed to weanling pigs. Each blood product was used in the amount of 20% as the sole source of P in a cornstarch-based diet that also contained sucrose, vitamins and minerals other than P. A P-free diet that was used to measure the basal endogenous loss of P was also formulated. Twenty 4 pigs (initial BW: 18.8 ± 3.2 kg) were randomly allotted to the 4 dietary treatments with 6 pigs per treatment. Pigs had 5 d of adaptation to diets followed by 5 d of total collection of feces. The ATTD of P was greater ($P < 0.01$) for pigs that were fed SDPP (91.91%) than for pigs that were fed either porcine blood meal (76.46%) or avian blood meal (57.67%), and pigs that were fed porcine blood meal also had greater ($P < 0.01$) ATTD of P than pigs that were fed avian blood meal. The basal endogenous loss of P was 219 mg/kg of DMI. There were no differences in the STTD of P between pigs that were fed porcine blood meal (89.74%) or avian blood meal (86.11%), but the STTD of P in these 2 ingredients was less ($P < 0.05$) than the STTD of P in SDPP (104.39%). In conclusion, results of this experiment demonstrated that blood products are excellent sources of digestible P in diets fed to weanling pigs, but SDPP has a greater STTD of P than porcine or avian blood meal.

Key Words: blood meal, phosphorus digestibility, pigs, spray dried protein plasma

226 Standardized total tract digestibility and relative bioavailability of phosphorus in dicalcium phosphate and corn distillers dried grains with solubles fed to growing pigs. S. R. Baker,* B. G. Kim, and H. H. Stein, *University of Illinois, Urbana.*

Two experiments were conducted to compare values for the standardized total tract digestibility (STTD) and the relative bioavailability of P in dicalcium phosphate (DCP) and corn distillers dried grains with solubles (DDGS) when fed to growing pigs. In Exp. 1, the apparent total tract digestibility (ATTD), the basal endogenous P loss (EPL), and the STTD of P in DCP (PCS Sales Inc., Northbrook, IL) and DDGS (Lincolnland Agri Energy LLC, Palestine, IL) were determined. Eighteen pigs (initial BW: 34.93 ± 1.04 kg) were allotted to 3 cornstarch-based diets in a randomized complete block design and housed individually in metabolism cages. Two diets contained DCP and DDGS, respectively, as the sole source of P and the last diet was a P-free diet that was used to measure EPL from the pigs. Results indicated that the ATTD of P in DCP and DDGS were 86.1 and 58.8%, respectively, and the STTD of P in DCP and DDGS were 93.1 and 63.1%, respectively. The EPL was determined at 174 mg/kg DMI. In Exp. 2, 40 2 pigs (initial BW: 29.02 ± 2.03 kg) were allotted to 7 dietary treatments in a randomized

complete block design. Pigs were housed individually and allowed ad libitum access to feed and water. A basal diet (0.22% P) based on corn, casein, cornstarch, and potato protein concentrate was formulated. Three additional diets were formulated by adding 0.04, 0.08, or 0.12% P from DCP to the basal diet to create diets containing 0.26, 0.30, or 0.34% P. The last 3 diets were formulated by adding 0.04, 0.08, or 0.12% P from DDGS to the basal diet at the expense of cornstarch. Pigs were fed experimental diets for 28 d. They were then killed and the third and fourth metacarpals from the right front foot were collected. Metacarpal bone ash was regressed against P intake for each ingredient, and via slope ratio methodology it was determined that the bioavailability of P in DDGS was 60% relative to that in DCP. It was concluded from this work that there is good agreement between values for the STTD of P and the relative bio-availability of P in DDGS.

Key Words: bioavailability, phosphorus, pigs, standardized digestibility

227 Effect of dietary phosphorus concentration on growth performance, phosphorus and calcium digestive and metabolic utilization in pigs from 20 to 100 kg BW. M. P. Létourneau-Montminy*¹, J. Y. Dourmad², C. Jondreville³, and C. Pomar¹, ¹*Agriculture and Agri-Food Canada, Sherbrooke, QC, Canada*, ²*INRA UMR1079, St-Gilles, France*, ³*INRA USC340, Nancy, France.*

Improving pig dietary phosphorus (P) utilization requires improving our capacity to predict dietary P digestion, its metabolic utilization and to precisely determine P requirements. The effect of varying dietary P concentration on growth performance and P digestive and metabolic utilization was studied. Fifty pigs (10/treatment) were fed individually according to a 3-phase feeding program (25–40, 40–70 and 70–100 kg BW) with 5 diets formulated to supply 60, 80, 100, 120 and 140% of the P requirement (NRC, 1998). Twelve additional pigs were slaughtered at the beginning and the 50 at the end of the experiment for body chemical composition. Pig body and bone composition was obtained by dual x-ray absorptiometry at the beginning and at the end of each growing phase. Total faeces and urine collection was performed with 18 additional pigs during the 2nd growing phase with the 60, 100 and 140% requirement diets. Growth performance was not modified by dietary treatments. Bone mineral content (g/d) and total body Ca retention (g/kg gain) increased quadratically (respectively, $P < 0.001$, $P < 0.01$) while P retention (g/kg gain) increased linearly ($P < 0.001$) with the increase of dietary P. These results and the high urinary losses of both Ca and P (respectively, 17 and 16 mg/kg BW per day) in pigs fed 140% of P requirement, indicate that maximal bone mineralization was reached in pigs fed 120% of P requirements. Total body P retention varied from 3.4 to 5.3 g/kg gain with increasing dietary P. The use of a fixed amount of retained P per unit of weight gain to estimate farms P excretion must be reconsidered when P is supplied to maximize bone mineralization. Optimal dietary P concentration can be established according to optimal bone mineralization and the desired P excretion.

Key Words: phosphorus, retention, pig

228 The effects of supplementing dietary organic trace minerals to gestating and lactating rations on mineral concentrations of the liver and plasma of reproductive swine. C. L. Bradley*¹, B. E. Bass¹, J. G. Powell¹, E. B. Kegley¹, Z. B. Johnson¹, C. V. Maxwell¹, M. E. Wilson², and T. L. Ward², ¹*University of Arkansas, Fayetteville*, ²*Zinpro, Inc., Eden Prairie, MN.*

The University of Arkansas Division of Agriculture swine breeding herd (n = 221, GPK348 x GPK5, GPK35, Newsham Choice Genetics) was used to determine the long-term (18-mo) effects of feeding complex minerals (Zn, Cu, Mn, and Cr) on liver and plasma mineral concentrations (P, K, Ca, Mg, S, Na, Fe, Mn, Zn, and Cu) of reproductive swine. The herd was on a batch farrowing system, which 1 group farrowed every 5 wk. Approximately 5 d before the initial breeding, gilts or sows were randomly assigned to 1 of 2 dietary treatments (TRT): a control diet containing an inorganic trace mineral premix (CTL; 100 ppm of Fe as iron sulfate, 125 ppm Zn as zinc sulfate, 0.20 ppm Se from selenium yeast, 50 ppm of Mn as manganese sulfate, 35 ppm of Cu as copper sulfate, and 0.35 ppm of I as calcium iodate) or the control diet premix supplemented with organic trace minerals (ORG; 40 ppm of Zn from Availa[®] Zn, 25 ppm of Cu from Availa[®] Cu, 20 ppm of Mn from Availa[®] Mn replacing equal amounts of inorganic Zn, Cu, and Mn, plus 0.40 ppm of Cr from MiCroPlex[®] chromium-L-methionine; Zinpro Corporation, Eden Prairie, MN). Gilts and sows remained on the same dietary treatments throughout the study. Culling and gilt replacement was conducted on as-needed basis for each breed group and gilts were randomly assigned to one of the 2 treatments. Sows were fed approximately 2.5 kg of feed during gestation and ad libitum during lactation. Liver samples (n = 150) and plasma samples (n = 489) were taken within a wk of breeding and the subsequent weaning/breeding periods. Approximately 50% of the feed batches were sampled and analyzed for mineral concentrations and were not different for TRT ($P \leq 0.09$). Sows fed ORG had a greater Cu (34.95 ± 3.95 vs. 19.65 ± 3.63 , $P < 0.01$) liver concentration than sows fed the CTL. Sows fed ORG also had a tendency ($P = 0.06$) for lower P liver concentrations than sows fed CTL. There were no TRT differences for plasma mineral concentrations ($P \leq 0.26$). This study suggests that feeding additional organic trace minerals to reproductive swine may enhance Cu storage in the liver.

Key Words: sows, minerals, liver, plasma

229 Effect of organic trace minerals (copper, manganese and zinc) on performance and carcass characteristics of grow-finish pigs. J. Graham^{*1}, G. Walker², K. Ridenour², and C. Hostetler¹, ¹*South Dakota State University, Brookings*, ²*Global Animal Products, Inc., Amarillo, TX*.

Mixed-gender, crossbred pigs (n = 144) were used in a 2X2 factorial experiment to determine the effects of feeding liquid organic trace minerals (LiquiTrace[®], Global Animal Products, Inc., Amarillo, Texas) during the growing and finishing period. Treatments consisted of inorganic trace minerals and a combination of inorganic:organic sources of copper, manganese and zinc in 50:50 ratios supplemented to supply either NRC recommendations or current industry standards. Pigs were weighed at the initiation of the trial, blocked according to weight and randomly allotted to pens (3 pigs per pen, 12 pens per treatment) on totally slotted concrete floors in an environmentally controlled building. Average initial BW was 20.5kg and average BW at termination of the trial was 117.8 kg. No treatment differences were observed for animal performance (ADG, ADFD, G:F), carcass characteristics (HCW, LMA, fat thickness, color, marbling, ultimate pH, or drip loss) or serum hormone concentrations. Pigs fed diets formulated to meet industry standards from the 50:50 inorganic:organic treatments had firmer muscle compared with inorganic sources (1.69 vs 1.32 muscle score; $P = 0.003$); however, no differences were observed at NRC recommended concentrations. Barrows grew faster (1.01 vs 0.90 kg/d; $P < 0.001$) and consumed more feed (2.92 vs 2.53 kg/d; $P < 0.001$) compared with gilts. Additionally, barrows had improved

firmness (1.76 vs 1.32 firmness score; $P < 0.001$), marbling (2.21 vs 1.81 marbling score; $P < 0.001$) and intermuscular fat (2.99 vs 2.36% fat; $P < 0.001$) compared with gilts. The results of this trial indicate that animals fed diets supplemented with the combination inorganic and organic sources of trace minerals performed as well as animals fed diets supplemented with inorganic sources. Additionally, there were no differences between the concentrations of trace element supplementation thus, formulating diets to meet NRC recommendations provides sufficient dietary trace minerals to support normal growth.

230 Meta-analysis of phosphorus utilization by broilers: effect of dietary calcium concentration and microbial phytase supply. X. Rousseau^{*1,2}, M. P. Letourneau-Montminy³, N. Meme¹, M. Magnin², Y. Nys¹, and A. Narcy¹, ¹*INRA UR83 Poultry Research, Nouzilly, France*, ²*BNA Animal Nutrition, Château-Gontier, France*, ³*Agriculture and Agri-food Canada, Sherbrooke, QC, Canada*.

The effect of dietary calcium (Ca) on phosphorus (P) utilization has been extensively studied in broilers from 0 to 21 d of age. However, there is limited information regarding its impact on P utilization after 21d. In fact, more than 60% of the overall feed intake occurs during this phase which also leads to high P excretion considering that around 50% of the ingested P is not retained. A meta-analysis has therefore been performed to improve our knowledge on P utilization in growing-finishing broilers from 14 to 63 d of age. Literature data regarding this period were compiled to determine laws of response to dietary non-phytate P (NPP) concentration in terms of growth performance (ADG) and bone mineralization (tibia ash content), taking into account dietary Ca and microbial phytase supply. The database includes 37 trials representing 212 treatments. At low dietary NPP concentration, high dietary Ca concentration deteriorated ADG but this effect was reduced when increasing dietary NPP (Ca x NPP, $P = 0.006$). The response of birds to microbial phytase had a positive effect on ADG regardless of dietary Ca concentration but this effect was reduced when increasing dietary NPP (NPP x phytase, $P < 0.001$). Furthermore, at low NPP concentrations, high dietary Ca reduced tibia ash content (Ca x NPP, $P < 0.001$), whereas at higher NPP concentrations, this last criterion was enhanced by dietary Ca. The response of birds to microbial phytase supply was greater when decreasing dietary NPP (NPP x phytase, $P < 0.001$) and when increasing dietary Ca (Ca x phytase, $P = 0.006$). These results underline that Ca must be finely managed to minimize negative impacts on growth performance while maintaining acceptable levels of bone mineralization, notably in phytase supplemented diets.

Key Words: phosphorus, calcium, microbial phytase, broiler

231 Modifications in phosphate status effect growth performance and satellite cell proliferation in neonatal pigs. L. S. Alexander, B. S. Seabolt, and C. H. Stahl,* *North Carolina State University, Raleigh*.

Satellite cells are essential to postnatal muscle growth and our previous research indicates that dietary P deficiency reduces proliferation of these muscle stem cells (Alexander, 2010). The objective of the present study was to examine the impact of excess dietary P on the growth, endocrine profile, and satellite cell proliferation of neonatal pigs. Seventy-five pigs (1 d of age, both sexes) were pair-fed either a 25% P deficient (PD), a P adequate (PA), or a 25% excessive P (PE) liquid diet for 18 d. Blood was collected every 6 d over the course of the study. While circulating P did not differ between the PA and PE fed groups, sera P was lower ($P < 0.05$) in PD fed animals by d 6 and remained so until trial completion. Sera calcium (Ca) concentrations were higher (P

< 0.05) in PD fed animals at all time points when compared with their PE fed counterparts, while PA fed animals did not differ from either group. Increased ($P < 0.05$) sera PTH was observed in those animals receiving the PE diet when compared with the PD and PA fed groups throughout the trial. As is typical in P deficiency, PD fed animals had lower ADG ($P < 0.05$) and were less efficient at feed conversion ($P < 0.05$) than PA and PE fed animals. Bromo-deoxyuridine (BrdU) staining performed on satellite cells isolated from 21 animals (7/treatment group) at d 12, demonstrated reduced ($P < 0.05$) proliferation in PD fed animals. No differences were noted between the PA and PE treatment groups. The changes in growth performance and circulating mineral and hormone levels in the present study were all indicative of modifications in dietary P. Although our previous research illustrated reduced satellite cell proliferation during P deficiency, dietary P in excess of adequacy did not result in increased proliferation. Additional research is needed to further clarify how P status affects satellite cell activity and the subsequent changes in growth.

Key Words: pig, phosphate, satellite cell

232 Digestibility of GE and TDF in diets containing novel carbohydrates fed to growing pigs. S. K. Cervantes-Pahm* and H. H. Stein, *University of Illinois, Urbana.*

An experiment was conducted to determine the apparent ileal (AID) and apparent total tract (ATTD) digestibility and the hindgut disappearance (HGD) of total dietary fiber (TDF) and GE in pig diets containing 4 novel carbohydrates. The novel carbohydrates included 2 starches with 60 or 75% resistant starch (RS 60 and RS 75, respectively), soluble corn fiber (SCF), and biogum (BG). Solka floc was included as a control. A basal diet based on maltodextrin and casein was formulated and 5 diets were formulated by substituting 10% maltodextrin with 10% RS 60, RS75, SCF, BG, or solka floc. Twelve pigs (20.0 ± 0.98 kg) with ileal canulas were used in a replicated 6 × 6 Latin square design with 6 diets and 6 9-d periods in each square. Fecal and ileal samples were collected on d 6–7 and d 8–9, respectively. There were 12 observations per diet. Results indicated that the AID of TDF in the BG diet (46.4%) was not different from that in the diet containing RS 60 (37.7%), but greater ($P < 0.001$) than in all other diets (range: -11.4 to 25.3%). The ATTD of TDF (range: 30.5 to 61.8%) in diets containing solka floc, RS 60, RS 75, and BG were not different, but these values were greater ($P < 0.05$) than the ATTD of TDF in the control diet and the diet containing SCF (-68.1 and -24.2%, respectively). The HGD of TDF in the control diet (-56.2%) was also less ($P < 0.05$) than in all other diets and the HGD of TDF was greater ($P < 0.05$) in the diets containing RS60 and RS75 than in the SCF-diet. The AID of GE in diets containing RS 60, RS 75, SCF, and BG (range: 88.5 to 92.2%) were less ($P < 0.05$) than in the control diet (96.9%), but the AID of GE in the diet containing solka floc (85.9%) was the least ($P < 0.001$) among all the diets. The ATTD of GE in diets containing RS 60, RS 75, SCF, and BG (range 92.6 to 95.7%) were not different from the ATTD of GE in the control diet (94.6%), but the ATTD of GE in the solka floc diet (91.1%) was less ($P < 0.05$) than in the control diet and in diets containing RS 60 or SCF. The HGD of GE was also less ($P < 0.05$) in the control diet (-2.2%) and the BG diet (0.3%) than in all other diets (4.3 to 5.2%). In conclusion, addition of 10% RS 60, RS 75, SCF, or BG to a maltodextrin-based diet reduced the AID, but not the ATTD, of GE in the diets.

Key Words: carbohydrates, energy, pigs, total dietary fiber

233 Carcass measurements and predicted carcass lean percentage of pigs fed diets with high or low metabolizable and net energy concentration. A. P. Schinckel*¹, M. E. Einstein¹, S. Jungst², B. Fields², N. Matthews², C. Fralick³, A. Sosnicki², and R. D. Boyd⁴, ¹Purdue University, West Lafayette, IN, ²PIC North America, Hendersonville, TN, ³Swine Tek, LLC, Convoy, OH, ⁴Hanor Companies, Franklin, KY.

This trial was done to evaluate the impact of dietary energy concentration on pork carcass composition. Barrows (n = 2,178) and gilts (n = 2,274) from 4 sire lines were fed either high (HE) or low energy (LE) diets from 27 kg BW to target BWs of 118, 127, 131.5 or 140.6 kg. The LE diets had 3.14 to 3.19 Mcal ME/kg, and 16 to 23% wheat middlings. The HE diets had (3.41 to 3.45 Mcal ME/kg) and 4.5 to 4.95% choice white grease. Diets were corn-soybean meal based and contained 6% DDGS. Pigs were marketed at a pork processor, which measured carcass weight, optical probe backfat (BF) and loin depth (LD). Carcass lean percentage (LEAN%, plant equation) and fat-free lean percentage (FFL%) were predicted from BF and LD. Dressing percentage was affected by diet ($P = 0.04$, 73.67 versus 74.35% for LE and HE). Overall, BF was affected by diet ($P = 0.05$, 18.4 versus 19.0 mm for LE and HE), sex ($P < 0.001$, 16.89 and 20.91 for gilts and barrows) and target BW ($P = 0.02$, 15.8, 18.2, 19.1 and 22.5 mm at 118, 127, 131.5 and 140.6 kg BW). Overall, LM was not affected by diet (67.2 versus 66.9 mm for LE and HE, $P = 0.47$) but was impacted by sex (68.2 versus 65.9 mm, $P < 0.001$). Target BW affected LM ($P = 0.03$, 62.5, 66.1, 68.6 and 71.1 mm). Overall, LEAN% was affected by diet (56.1 versus 55.9%, $P = 0.05$), sex (56.8 versus 54.9%, $P < 0.001$) and target BW ($P = 0.02$, 56.6, 56.02, 55.95, and 55.2%). Overall, FFL% was affected by diet (50.8 versus 51.6%, HE and LE, $P = 0.05$), sex (52.9 versus 49.6%, gilts versus barrows; $P < 0.001$) and target BW (53.0, 51.7, 51.2 and 49.1%, respectively, $P = 0.03$). There were no ($P > 0.20$) interactions of diet with sire line, sex or target BW for any trait. These pigs can be fed to 131.5 kg BW with only small decreases in carcass leanness.

Key Words: dietary energy, pig, carcass composition

234 Daily feed intake, energy intake and growth rate of pigs fed diets with high or low metabolizable and net energy concentrations. A. P. Schinckel*¹, M. E. Einstein¹, S. Jungst², C. Booher², T. Dreadin², C. Fralick³, E. Wilson², and R. D. Boyd⁴, ¹Purdue University, West Lafayette, IN, ²PIC North America, Hendersonville, TN, ³Swine Tek, LLC, Convoy, OH, ⁴Hanor Companies, Franklin, KY.

Pen feed intake data (2,178 barrows and 2,274 gilts) were obtained from 27 kg BW to target BWs of 118, 127, 131.5 and 140.6 kg. The pigs from 4 sire lines were allocated to a series of low energy (LE, 3.14 to 3.19 McalME/kg) corn-soybean meal based diets with 16 to 23% wheat middlings or high energy diets (HE, 3.41 to 3.45 Mcal ME/kg) and 4.5 to 4.95% choice white grease. All diets contained 6% DDGS. The HE and LE diets of each of the 4 phases were formulated to have equal lysine:Mcal ME ratios. Pigs were weighed and pen feed intake recorded at 28-d intervals. The barrow and gilt daily feed (DFI), ME (MEI) and NE (NEI) intake data were fitted to a Bridges function of BW. The BW data of each sex were fitted to a generalized Michaelis-Menten function of days of age. There was a sire line by sex interaction for ADG ($P = 0.004$) with the barrows and gilts of each sire line having mean ADGs of 981 versus 914, 997 versus 924, 912 versus 833, and 984 versus 944 g/d for sire lines 1 to 4, respectively. Overall, ADG was less (915 g/d versus 945 g/d, $P < 0.001$) for pigs fed the LE than HE diets. Overall, DFI was greater ($P < 0.001$) for pigs fed the LE diets (2.62 versus 2.45 kg/d). However, no differences were observed

for MEI (8.52 versus 8.54 Mcal/d, $P = 0.49$) or NEI (6.39 versus 6.44 Mcal/d, $P = 0.13$). Overall gain:feed (0.362 versus 0.377), ADG:Mcal MEI (0.113 versus 0.117) and ADG:Mcal NEI (0.198 versus 0.2045) were less ($P < 0.001$) for pigs fed the LE than HE diets. Sire line by sex interactions existed ($P < 0.02$) for ADG:Mcal MEI and ADG:Mcal NEI. Pigs fed the LE diets had nearly identical daily NE and ME intakes but grew slower and less efficiently than pigs fed the HE diets.

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

235 The impact of feeding diets of high or low metabolizable and net energy concentration of weight of primal and subprimal lean cuts.

A. P. Schinckel^{*1}, M. E. Einstein¹, S. Jungst², C. Booher², B. Fields², N. Matthews², C. Fralick³, A. Sosnicki², and R. D. Boyd⁴, ¹Purdue University, West Lafayette, IN, ²PIC North American, Hendersonville, TN, ³Swine Tek, LLC, Convoy, OH, ⁴Hanor Companies, Franklin, KY.

Barrows (n = 2,178) and gilts (n = 2,274) from 4 sire lines were phase fed a series of either high energy (HE) or low energy (LE) diets from 27 kg BW to target BWs of 118, 127, 131.5 and 140.6 kg. The LE diets fed had 3.14 to 3.19 Mcal ME/kg, and 16 to 23% wheat middlings. The HE diets had 3.41 to 3.45 Mcal ME/kg and 4.5 to 4.95% choice white grease. All diets contained 6% DDGS and were formulated within phases to the same lysine:Mcal ME ratios. The weight of carcass primal and subprimals were collected. The weight of each cut was fitted to allometric functions ($Y = AX^B$) of carcass weight. The significance of diet, sex or sire line with A and B was evaluated by transforming the equations to a linear form using log to log-transformation. The effect of diet on A did not interact ($P > 0.20$) with sex or sire line. Thus, the final model was cut weight = $(1 + (C \{Diet\})(A(CW)^B)$ where Diet = -0.5 for the LE and 0.5 for HE diets and A and B are sire line – sex specific parameters. The value of C is an multiplicative estimate of the diet effect with a value of C = 0.01 indicating a 1% greater value for HE pigs than LE pigs. Diet had no impact on wholesale loin, Boston butt, picnic, baby back rib, or sparerib weights ($P > 0.10$, C = -0.003, -0.0029, 0.0002, 0.0047, -0.0025). Three muscle ham weight was affected by diet (C = -0.014, $P = 0.001$) as was boneless loin (C = -0.010, $P = 0.001$), tenderloin (C = -0.023, $P = 0.001$) and sirloin weight (C = -0.009, $P = 0.034$). Feeding the HE diets had little impact on primal cut weight except to increase belly weight. The HE diets reduced the weight of lean trimmed cuts by 1 to 2 percent.

Key Words: dietary energy concentration, carcass, pork, primal weight

236 Is starch an essential nutrient for growing pigs? X. Zeng^{*1,2} and A. D. Beaulieu¹, ¹Prairie Swine Centre Inc., Saskatoon, SK, Canada, ²University of Saskatchewan, Saskatoon, SK, Canada.

Distillers dried grains with solubles (DDGS), a by product of the ethanol industry, are widely used in the swine industry. The main difference between DDGS and the parent grain is the low starch content of the DDGS, which was converted to ethanol during fermentation. Diets formulated with high DDGS will therefore have a reduced starch content. The overall objective of this experiment was to determine if reduced dietary starch will limit protein deposition in growing pigs. Six diets, consisting of 5 semi-purified iso-nitrogenous and iso-caloric diets with increasing starch content (0, 5.5, 11, 16.5 and 22%) and one commercial reference diet were fed to growing pigs for 26 d. Diets were made iso-caloric with canola oil. Four blocks of 12 gilts (8.5 ± 1 kg) each were randomly assigned within block to one of the 6 treatments. Two additional pigs from each block were slaughtered on d 0

for baseline carcass measurements. ADG improved as starch content increased ($P < 0.05$), but ADFI (0.68 kg/d) and gain/feed (0.67) were unaffected ($P > 0.1$). Gross energy and DM digestibility improved, but ether extract digestibility decreased with increasing starch ($P < 0.05$). Crude protein digestibility tended to increase as the content of dietary starch increased ($P = 0.06$). Blood metabolites were measured for 8 h post-feeding on d 24. C-peptide (pro-insulin) increased and BUN decreased with increasing starch ($P < 0.05$). Blood glucose concentration, however, was similar between treatments (6.1 mmol/L; $P > 0.05$). Carcass protein and water deposition increased with increasing dietary starch ($P < 0.05$). The efficiency of utilization of CP for protein gain tended to increase with increasing starch content ($P = 0.10$). Fat and ash deposition were unaffected by treatment ($P > 0.05$). In conclusion, protein deposition improved with increasing starch content of the diet. Maximizing the inclusion of DDGS in swine diets may require a consideration of the starch content of the overall diet to maintain optimal protein deposition.

Key Words: swine, starch, DDGS

237 The effects of feeder design, wet-dry feeder adjustment strategy, and diet-type on the growth performance and carcass characteristics of growing-finishing pigs. J. R. Bergstrom,^{*} M. D. Tokach, S. S. Dritz, J. L. Nelssen, J. M. DeRouchey, and R. D. Goodband, Kansas State University, Manhattan.

A total of 1,287 pigs (PIC 337 \times 1050, initially 38 kg) were used to compare the effects of a conventional dry (CD) feeder, 3 wet-dry (WD) feeder adjustment strategies, and 2 diet-types on finishing pig performance (4 \times 2 factorial arrangement). For pigs with a CD feeder, water was provided separately with a cup waterer. Water was provided in the feeder trough for pigs with a WD feeder. There were 27 pigs/pen and 6 pens/treatment in a CRD. The WD adjustment strategies were: 1) setting of 18 (3.2 cm opening) for the entire study (WD18); 2) setting of 18 until d 56 with a setting of 14 (2.5 cm opening) from d 56 to 92 (end of the experiment; WD14); and 3) setting of 18 until d 28, setting of 14 from d 28 to 56, and a setting of 10 (1.9 cm opening) from d 56 to 92 (WD10). The CD feeder remained at the same setting (~2.3 cm below gate) from d 0 to 92. The 2 diet-types were a corn-soybean meal-15% DDGS diet and a corn-25% DDGS-20% bakery by-product-soybean meal diet. Overall (d 0 to 92), pigs fed using the WD feeder had greater ($P < 0.001$) ADG, ADFI, and final BW than pigs fed with the CD feeder. However, within the WD treatments, pigs fed with WD14 and WD10 had reduced ($P < 0.05$) ADG (both 1.01 kg/d) compared with pigs fed with WD18 (1.04 kg/d). Additionally, ADFI of pigs fed using WD10 was lower (2.70 kg/d; $P < 0.05$) than that of pigs fed with WD18 (2.79 kg/d), with WD14 being intermediate (2.74 kg/d). There were no differences in G:F among feeder treatments, and growth performance was similar between the 2 diet types. Pigs fed using the WD feeder had greater ($P < 0.02$) HCW, yield, backfat depth, revenue per pig, and feed cost per pig than pigs fed with the CD feeder. Loin depth of pigs fed using the WD feeder was less ($P < 0.04$) than that of pigs fed with the CD feeder. Differences in backfat and loin depth resulted in pigs using the WD feeder having lower ($P < 0.001$) fat-free lean index (FFLI) than pigs fed with the CD feeder. However, within the WD feeder treatments, pigs fed with WD10 had reduced ($P < 0.05$) backfat depth and increased ($P < 0.05$) FFLI compared with pigs fed with WD18, with WD14 being intermediate. In conclusion, a reduced setting of the WD feeder in later growth periods improved carcass leanness while maintaining an advantage in growth rate.

Key Words: dry feeder, feeder adjustment, wet-dry feeder

238 Effect of gestation housing systems on reproductive performance and oxidative status of sows during gestation and lactation. Y. Zhao*¹, W. L. Flowers¹, A. Saraiva^{1,2}, K.-J. Yeum³, and S. W. Kim¹, ¹North Carolina State University, Raleigh, ²Universidade Federal de Viçosa, Viçosa, MG, Brazil, ³Tufts University, Boston, MA.

Two types of gestational housings were used to evaluate the effects on reproductive performance, physiological status, and behavior of sows during gestation and lactation. Ninety 6 multiparous sows were randomly assigned to either the individual crate (CON) or group pen (PEN) on d 35 of gestation. Behaviors of sows were video recorded and observed for the first 4 d after housing assignment on d 35 of gestation. On 6 d before farrowing date, sows were moved to individual farrowing crates. Sows were weighed on d 35 and 109 of gestation, and d 1 and 18 of lactation. Jugular blood was collected from all sows on d 35, 60, 90, and 109 of gestation, and on d 3 and 18 of lactation. Plasma malondialdehyde (MDA), protein carbonyls (PCS), 8-hydroxy-deoxyguanosine (8OHdG), and immunoglobulins (Ig) G and M were quantified. Litter size and piglet BW were recorded on d 1 and 18 of lactation. Sows in PEN gained less BW ($P < 0.05$) than sows in CON during gestation. Sows in PEN tended to have smaller ($P = 0.069, 0.096$) litter size than sows in CON on d 1 and 18 of lactation, respectively. Sows in PEN tended to have smaller ($P = 0.089$) litter weight than sows in CON on d 1 of lactation. Sows in CON and PEN had greater ($P < 0.05$) 8OHdG on d 109 of gestation than d 35 of gestation. Plasma PCS on d 109 of gestation was greater ($P < 0.05$) than d 90 of gestation for sows in CON. Plasma PCS on d 109 of gestation was greater ($P < 0.05$) than d 60 of gestation and d 18 of lactation for sows in PEN. Plasma and colostrum IgG and M did not differ between treatments. The eating time of sows in PEN tended to be less ($P = 0.060$) than sows in CON. Collectively, sows had reduced reproductive performance when housed in pens during gestation, and oxidative stress of sows was elevated during late gestation and early lactation compared with early gestation regardless of gestation housing systems.

Key Words: gestation crate, oxidative stress, pen, sow

239 Effect of increasing feeding levels in sows during late gestation on piglet birth weights. J. Soto*¹, L. Greiner¹, J. Connor¹, and G. Allee^{2,1}, ¹Innovative Swine Solutions, LLC, Carthage, IL, ²PorkTech, LLC, Columbia, MO.

A group of 224 (C22 and C29) sows (parity 1 $n = 72$, parity 2 $n = 24$, parity 3 $n = 36$, and parity 4 or more $n = 92$) sows were assigned to one of 3 treatments 14 d before farrowing to determine the effect of increasing feeding levels during late gestation on individual piglet and litter birth weights. One week of a commercial farm's bred gilts and sows were randomly allotted to one of 3 treatments (0, 0.91, 1.82 kg feed increase). Treatments were blocked within parity and body condition score. Gestating females were fed the dietary treatment starting 14 d pre-farrow. Two days before farrowing, the animals were moved into the farrowing house where feed intake was reduced to 1.82 kg per day of lactation feed until farrowing. Gestation diets were formulated to 0.55% total lysine. All other nutrients met or exceeded NRC (1998) requirements. Individual pre-suckle birth weights were collected on litters when farrowings were attended. All other farrowings were recorded as post-suckle total litter weights. Both measurements included stillborn and mummified fetuses in the analysis. Number of total born and born alive had no significant differences between treatments. Total litter weights, total born alive weights, individual piglet weights and individual stillborn weights had no significant differ-

ences in multiparous (P2 or more) sows. However, total litter weights was significantly ($P = 0.019$) higher in parity 1 (P1) sows fed with 1.82 kg than P1 sows fed with no extra feed (16.1 vs. 18.7 kg, respectively) as well as total born alive weights was significantly ($P = 0.030$) higher (15.1 vs. 16.6 kg, respectively). Furthermore, individual born alive weights was significantly ($P < 0.001$) higher in P1 sows fed with 1.82 kg than P1 sows fed with no extra feed (1.312 vs. 1.438 kg, respectively). Based on these data, feeding parity 1 females 1.82 kg per day additional feed from d 100 to parturition improves piglet birth weight, but does not improve piglet birth weight in multiparous sows.

Key Words: sow, birth weight, feeding level, gestation

240 Umami taste stimulation improves the performance of weanling pigs. G. Tedó*¹, C. Risley², and I. Ipharraguerre¹, ¹Lucta S.A., Barcelona, Spain, ²Lucta USA Inc., Libertyville, IL.

In response to the consumption of some protein-born chemicals, pigs perceived a pleasant taste called *umami*. Data from in vitro studies using a cell reporter system that expresses the porcine umami taste receptor, suggest that besides monosodium glutamate (MSG), L-Glu, L-Gln, and L-Ala, pigs perceive other substances as umami tastants. Results from later in vivo studies with weanling piglets supported the above suggestion by showing that combinations of some of those umami substances appear to be more potent and effective than MSG at stimulating the umami taste in pigs. Data reported herein is from a follow-up study aiming to investigate the impact of adding a high-intensity umami flavor (HIU) into transition diets on the performance of weanling piglets. A total of 96 piglets (*Landrace x Large White*) weaned at 23 d of age were used. Piglets were allotted to 2 dietary treatments (6 pens of 8 pigs each/treatment) following a randomized complete block design with 3 blocks of BW. Treatments were CON (control diets) or HIU (CON diets flavored with 1500 ppm of HIU) and were fed during the pre-starter (0–14 d) and starter (15–28 d) phases. The experimental diet was pelleted, medicated, and formulated to meet piglets' nutrient requirements (NRC, 1998). Performance data was recorded weekly and analyzed using a mixed-effect model with repeated measures that included the random effect of pen and the fixed effect of treatment, block, and their interaction. During the first week after weaning, HIU piglets consumed more feed (87 vs. 133 g/d, $P < 0.05$) and grew faster (62 vs. 124 g/d, $P < 0.05$) than CON piglets. By the end of the study, animals fed HIU diets reached higher BW (16.13 vs. 17.30 kg, $P < 0.05$) and ADG (346 vs. 393 g/day, $P < 0.05$) but lower FG ratio (1.24 vs. 1.12, $P = 0.06$) than piglets fed CON. Within the HIU group and during the pre-starter phase, lighter piglets tended to grow faster ($P = 0.09$) than their heavier counterparts. In conclusion, adding HIU into piglet diets may improve animal performance and reduce variability in BW gain during the transition phase.

Key Words: umami, flavor, piglet

241 The effects of feeder adjustment on growth performance of finishing pigs. A. J. Myers,* R. D. Goodband, M. D. Tokach, S. S. Dritz, J. R. Bergstrom, J. M. DeRouchey, and J. L. Nelssen, Kansas State University, Manhattan.

A total of 234 growing pigs (initial BW 41.5 kg) were used in an 89-d trial to determine the effects of feeder adjustment (1.27, 1.91, or 2.54 cm minimum gap opening) on finishing pig performance. Feeders (Farmweld; Teutopolis, IL) were adjusted to a minimum gap setting, but the agitation plate could be moved upward to a maximum opening of 1.91, 2.54, or 3.18 cm, respectively. Treatments were arranged

in a completely randomized design with 9 replications of 8 pigs/pen and 1 replicate with 6 pigs/pen. To ensure equal floor space, pen gating was adjusted to provide 0.74 m² per pig. All pens had the same feeder with 2, 35.6 cm-wide by 11.4 cm-deep feeder holes. Pigs had ad libitum access to corn-soybean meal-based diets containing 20% corn dried distillers grains with solubles. Pen weights and feed disappearance were measured every 2 wk. Pictures of feeders were taken and scored to determine percentage pan coverage. Feeder adjustments of 1.27, 1.91, and 2.54 cm averaged 28, 58, and 75% pan coverage, respectively. From d 0 to 28, pigs exposed to increasing feeder gap had improved (linear; $P = 0.04$) ADG and ADFI, with the maximum ADG observed at 1.91 cm and the greatest ADFI at 2.54 cm. From d 28 to 56 and 56 to 89, G:F was highest for pigs fed from the 1.27 cm gap. Overall (d 0 to 89), there was a trend ($P = 0.08$) for increased ADG with increased feeder opening. However, pigs fed with a 1.27 cm feeder gap had improved (linear; $P < 0.03$) G:F compared with those with a 1.91 or 2.54 cm feeder opening. These results suggest that from 41 to 68 kg, ADG was optimized at the middle feeder setting of 1.91 cm. However, pigs fed from 68 to 122 kg had greater ADG and the best G:F at the lowest setting of 1.27 cm. Thus, it appears the optimum feeder-gap setting may differ by growth phase.

Table 1. Effects of feeder gap setting on finisher pig performance, (d 0 to 89)

Item	Feeder gap, cm			SEM		P-value
	1.27	1.91	2.54	Linear	Quadratic	
d 0 to 28						
ADG, kg	0.88	0.97	0.96	0.025	0.03	0.07
G:F	0.394	0.389	0.380	0.005	0.03	0.07
d 28 to 56						
ADG, kg	1.07	1.09	1.10	0.025	0.51	0.88
G:F	0.343	0.323	0.329	0.005	0.07	0.06
d 56 to 89						
ADG, kg	0.68	0.66	0.68	0.025	0.92	0.57
G:F	0.289	0.275	0.276	0.005	0.10	0.26
d 0 to 89						
ADG, kg	0.88	0.91	0.91	0.013	0.08	0.36
G:F	0.342	0.329	0.328	0.004	0.03	0.18

Key Words: feeder adjustment, feeder, finishing pig

242 Effect of determining baseline plasma urea nitrogen (PUN) concentrations on subsequent post-treatment PUN in 20- to 50-kg pigs. A. M. Waguespack^{*1}, M. L. Roux¹, A. Donsbough¹, S. Powell¹, T. D. Bidner¹, R. L. Payne², and L. L. Southern¹, ¹Louisiana State University, Agricultural Center, Baton Rouge, ²Evonik-Degussa Corp., Kennesaw, GA.

Plasma urea nitrogen can be used as an indicator of AA requirements and efficiency of AA utilization in swine. However, PUN may vary among a population of pigs fed the same diet and within a close range of BW. Thus, baseline PUN concentrations are commonly used as a covariate to reduce variation of post-treatment PUN. However, this procedure increases experiment costs and stress to the pig. Over the past 3 yr, we have conducted 14 experiments (26 to 28d in duration) using PUN as a response. Each of these experiments had 4 to 6 treatments. The purpose of this report is to summarize the effect of determining baseline PUN concentrations on subsequent post-treatment

PUN concentration in 20- to 50-kg pigs. Pigs were fed corn-soybean meal positive control and low CP diets with various AA additions. In all experiments, pigs were assigned to dietary treatments in a randomized complete block design with a minimum of 4 replicates of 3 to 5 pigs each. Before the start of each experiment, all pigs were fed a common diet. Blood samples were collected from each pig before allotment to dietary treatments (d 0) and at the termination of each experiment. The baseline (d 0) PUN was analyzed as a covariate for the PUN determined at the end of each experiment. Data were analyzed with and without baseline PUN. In 7 of the 14 experiments, the covariate baseline PUN was significant ($P < 0.10$). However, in all experiments combined, there were 768 possible treatment comparisons, and there were only 3 treatment differences that changed significance as a result of analyzing the data with the baseline PUN as a covariate. These 3 differences were in one experiment. These results indicate that it is not always necessary to determine baseline PUN concentrations because PUN is a single point-in-time measure.

Key Words: plasma urea nitrogen, pigs

243 Effect of non-essential amino acid supplementation in low crude protein amino acid supplemented diets for late finishing pigs. A. Rojo^{*1}, L. Ochoa¹, Z. Li¹, W. Xiao¹, O. F. Mendoza¹, J. Charal¹, M. Ellis¹, and A. M. Gaines², ¹University of Illinois, Urbana, ²The Maschhoffs, Carlyle, IL.

There has been limited research to establish if non-essential amino acids (NEAA) become limiting to growth performance in late finishing pigs fed low CP diets with increasing L-lysine (Lys)·HCl levels. The objectives of this study were to define the maximum inclusion level of L-Lys·HCl and whether NEAA become limiting in low CP diets for late finishing pigs. Individually penned barrows (n = 142; BW 89.4 ± 5.16 kg) were randomly allotted to 8 dietary treatments in a RCBD with 18 replicates. Trt. One through 5 contained increasing levels of L-Lys·HCl (0.00, 0.125, 0.225, 0.338 and 0.450%; with corresponding dietary CP levels of 13.0, 12.0, 10.7, 9.5, and 8.4%, respectively). Diets were formulated to the same ME (3.3 Mcal/kg) and standard ileal digestible (SID) Lys levels (0.60%) and met or exceeded NRC (1998) recommendations for other nutrients. Levels of other essential AA were kept constant across diets by the addition of crystalline AA. Diets for Trt. 6, 7, and 8 were formulated to the same NEAA levels as Trt. One by the addition of NEAA (50:50% mixture of glycine and glutamic acid) to Trt. 3, 4, and 5, respectively. Diets were fed over a 4-wk period. Increasing L-Lys·HCl resulted in a decrease (quadratic, $P \leq 0.05$) in ADG (1.147, 1.143, 1.156 and 1.118, and 0.999 kg respectively), which was attributed to a lower ADG in pigs fed 0.450% L-Lys·HCl. Furthermore, increasing L-Lys·HCl lowered (quadratic, $P \leq 0.05$) G:F (0.352, 0.342, 0.350, 0.331, and 0.308, respectively). There were no differences in ADFI ($P \geq 0.05$) with increasing L-Lys·HCl level. Broken-line analysis suggested that the maximum L-Lys·HCl level for ADG, and G:F was 0.315 and 0.262%, respectively. There were no improvements ($P \geq 0.05$) in growth performance with NEAA supplementation, regardless of L-Lys·HCl level. These results suggest that late finishing pigs can be fed diets with high levels of L-Lys·HCl (SID Lys:CP = 5.80%) and NEAA were not limiting in the low CP diets evaluated.

Key Words: amino acids, finishing pigs, growth

244 The effect of heat stress on intestinal bacterial translocation and intestinal mucosal immune in rats. A. Lu^{*1}, X. Liu¹, F. Liu^{1,3},

and J. Xu^{2,4}, ¹Beijing University of Agriculture, CAU-BUA TCVM Teaching & Research Team, College of Animal Science and Technology, Beijing, ²China Agricultural University, College of Veterinary Medicine, ³Beijing Key Laboratory of TCVM, CAU-BUA TCVM Teaching & Research Team, Beijing, ⁴China Agricultural University, TCVM Laboratory, CAU-BUA TCVM Teaching & Research Team, College of Veterinary Medicine.

Previous researches shown that heat stress damaged the intestinal tract structure and decreased the production performance in rats and pigs. This paper would like to research about whether heat stress induce intestinal bacterial translocation(BT) and investigate the effects on intestinal mucosal immune in heat stress rats. Twelve male Sprague-Dawley(SD) rats were randomly divided into control and heat-stressed groups. Both groups were housed in an environment of 25 °C and 60% relative humidity (RH), although the heat-stressed group was also subjected to 40 °C and 60% RH exposure for 2 h every day for 3 successive days. Research includes observing intestinal structure by HE staining and electron microscope, the numbers of goblet cells by PAS staining, the secretion of IgA in small intestine by immunohistochemistry(IHC) staining, determining the intestinal bacterial translocation identified with API 20E and detecting the changes of T lymphocyte and its subsets CD3, CD4 and CD8 in mesenteric lymph node(MLN) by flow cytometry(FCM). The results

indicated that rat rectal and body surface temperatures were all significantly increased after heat treatment ($P < 0.05$). The jejunum and ileum were significant damaged and occurred intestinal bacterial translocation in MLN, and identified was *Escherichia coli* with the 99.9% similarity; FCM results shown that, compared with control group, the numbers of CD3+ cells were significantly decreased after heat treatment ($P < 0.01$), CD4+CD8- and CD3+CD4+ cells were also decreased ($P < 0.05$), however the numbers of CD4-CD8+ cells were increased after heat stress treatment ($P < 0.05$). In conclusion, our research indicated that heat stress impaired the intestinal barrier function and mucosal immune system, which led to bacterial translocation from the intestinal tract to the MLN, sequentially decreased the immunity of the organism.

Table 1. MLN the numbers of CD3, CD4 and CD8 in MLN between control and heat stress rats(%)

Group	CD3+	CD4-CD8+	CD4-CD8-	CD4+CD8+	CD4+CD8-	CD3+CD4+	CD3+CD8+
Control	72.43±3.03	18.43±2.03	4.95±0.46	3.18±0.98	75.24±1.61	78.43±0.78	22.45±3.44
Heat stress	54.06±3.15**	23.46±1.69*	4.95±1.42	2.80±0.12	68.95±3.13*	71.75±3.24*	25.42±2.49

Compared to control group, * $P < 0.05$, ** $P < 0.01$.

Key Words: heat stress, bacterial translocation, mucosal immune, T lymphocyte

Wednesday, March 16, 2011

SYMPOSIA AND ORAL SESSIONS

Nonruminant Nutrition: Energy

245 Energy Partitioning in Modern Meat Type Pigs. A. B. Strathe*¹, H. Jørgensen², J. A. Fernández², E. Kebreab¹, and A. Danfær², ¹Department of Animal Science, University of California, Davis, CA, United States, ²Department of Animal Health and Bioscience, Faculty of Agricultural Sciences, Aarhus University, Tjele, Denmark.

Selection programs continue to alter the partitioning of metabolizable energy (ME) intake into requirements for maintenance (ME_M), protein (PD) and lipid deposition (LD). The objective of the present investigation was to quantify energy partitioning in modern meat type pigs. A total of 18 crossbred (Danbred Landrace x Yorksire sows and Duroc boars) pigs from 3 litters were used in the experiment. Within litter, 3 pigs from each gender (barrows, boars and gilts) were selected on basis of similar birth weight. Pigs were fed 4 diets with decreasing balanced protein contents, which were based on barley, wheat and soybean meal supplemented with crystalline amino acids to meet or exceed Danish nutrient requirement standards. Nutrient balance and gas exchange were measured at approximately 25, 75, 120 and 150 kg body weight (BW) during which they were in metabolic cages and confined into open circuit respiration chambers for the determination of energy balance by both carbon-nitrogen and respiratory-quotient method. Data was analyzed by applying a multivariate nonlinear model in which PD and LD were the dependent variables. The approach was as follows, ME available for production (ME_P) represented the difference between ME intake and ME_M. The fraction (F) of ME_P available for PD and LD was not constant but a linear function of BW. Multiplying ME_P by F and 1-F yielded ME for PD (ME_{PD}) and LD (ME_{LD}), which were used with efficiencies k_p and k_l, respectively. Parameter estimation was done in the WinBUGS software using vague informative priors. The ME_M was estimated to be 0.84 (SE: 0.13), 0.89 (SE: 0.13) and 0.85 (SE: 0.13) (MJ × d⁻¹ × BW^{-0.60}) for barrows, boars and gilts, respectively (P > 0.10). It was estimated that barrows, boars and gilts designated 0.45 (SE: 0.04), 0.50 (SE: 0.04) and 0.46 (SE: 0.04) of ME_P toward PD at 25 kg BW (P > 0.10). The corresponding fractions at 120 kg BW were 0.30 (SE: 0.02), 0.39 (SE: 0.02) and 0.29 (SE: 0.02) for barrows, boars and gilts, respectively (P < 0.01), reflecting the high priority for PD in boars and in early life.

Key Words: Energy metabolism, Growth, Modeling

246 Varying corn particle size distribution affects the digestibility of energy for the growing pig. J. F. Patience*¹, A. L. Chipman¹, C. K. Jones¹, and T. Scheer², ¹Iowa State University, Ames, IA USA, ²Farmers' Co-operative Company, Ames, IA USA.

As the cost of corn and other ingredients rises, optimizing the grinding process to extract the greatest quantity of available energy becomes much more important. This experiment determined the impact of altering ground corn particle size standard deviation (PSSD) on the digestibility of dry matter and energy. Twenty growing barrows initially weighing between 50 and 60 kg were housed in individual pens

and fed diets containing 1 of 5 ground corn samples. Corn was ground through a roller mill to achieve a mean particle size of 550 microns, with PSSDs of 1.8, 2.0, 2.2, 2.4 or 2.6 microns. The experimental diets contained 96.25% of the corn sample plus minerals, vitamins and 0.40% titanium dioxide. Pigs were fed twice a day to supply 700g feed per day in replicate one and 875 g per day in replicate 2. There were 8 pigs per treatment. Fecal grab samples were collected on d 6 and 7 following introduction of the experimental diet. Pigs were then placed on a standard grower diet for 3 d, followed by another collection period. Pens and treatments were randomly assigned, except a pig could not be on the same treatment in both periods. Data were analyzed according to the randomized complete block design using PROC MIXED with PSSD considered a fixed effect. Across the 5 corn treatments, actual particle size averaged 561 microns, with a range from 545 to 599 microns. Actual PSSDs were 1.9, 2.1, 2.3, 2.5 and 2.7 microns. Digestibility of dry matter and energy varied in a quadratic fashion with PSSD: 85.3% and 85.8%, respectively with a PSSD of 1.9 microns, 84.1% and 84.2% with 2.1, 81.1% and 81.1% with 2.3, 83.0% and 83.4% with 2.5 and 84.5% and 85.0% with 2.7; P < 0.05. Detailed analysis of the corn samples revealed that as PSSD increased, the distribution of particle size subcategories changed in ways that explained the curvilinear digestibility response. It can be concluded that altering the PSSD alters the digestible energy content of corn by up to 5.8%.

Key Words: corn, swine, particle size, digestibility

247 Practical method for productive energy (NEM+g) estimation of soybean meal for growing pigs. R. D. Boyd,* C. E. Zier-Rush, and M. McGrath, The Hanor Company, Franklin, KY, USA.

This study was conducted to verify the productive energy (PE, NEM+g), for soybean meal (SBM). We present a growth assay format (28 d) that allows for practical validation of NE estimates. NE estimates vary widely, which largely precludes their general use. In principle, a corn-soybean meal diet (C-S) is used as reference standard with G:F ratio as the PE criterion. SBM was exchanged in increments for corn and amino acids. Fat (0.75%) and other ingredients were held constant. Corn served as the energy reference (2.646 Mcal NE/kg) and was validated for protein solubility and glucose release. SBM was estimated in prior growth assays to be 2.020 Mcal NE/kg (88% DM basis). Test SBM was chemically defined: DM, 11.1%; starch, 4.4%; CP, 47.6; A-H Fat, 1.9; CF, 3.4; NDF, 6.98; ADF, 4.27; Lysine, 2.94. A total of 1794 pigs (36.5 ± 0.4 kg) were allotted by weight within gender to 6 diet sets to be fed in early growth (from 36 to 66 kg, 100 pens, ca 19 pigs per pen and 8 pens per treatment by sex subclass). The C-S diet was allocated to 2 separate sets of pigs to establish a reliable G:F reference, from which deviation could be determined. SBM test diets were formed by summit blend of 0 and 0.40% crystalline lysine (HCl) diets having 0, 0.10, 0.20, 0.30, 0.40% lysine and SBM levels of 33.1%, 29.9, 26.7, 23.5, 20.3 (or 0, 3.2, 6.4, 9.6, 12.9% deletion).

Diets were fed ad libitum, in meal form and with care to minimize diet waste. Temperature was maintained within thermal neutral limits. Pigs averaged 65.9 kg (± 3) at the end of test. Diet did not affect feed intake (2.22 kg/d ± 0.02), growth rate (1.05 kg/d, ± 0.01) or G:F ratio (0.47 ± 0.005) ($P > 0.10$). G:F ratio for the reference diet was 0.48 (0.48, 0.48); SBM treatments averaged 0.46, 0.47, 0.47, 0.47 kg/kg for respective SBM deletion (0, 3.2, 6.4, 9.6, 12.9%). Regression analysis suggests that G:F slope with SBM deletion response did not differ from zero ($P > 0.70$). The G:F response to SBM level is described by: $-0.0003 \times \text{SBM \% removal} + 0.472$ (R^2 , 0.05). We conclude that the NE estimate for this SBM source is reliable (2.020 Mcal/kg, 88% DM) and that it is approximately 76.3% the PE value of corn.

Key Words: Pigs, SBM, Net Energy, Lysine

248 Increasing protease supplementation on two different types of sorghum in young male pigs. D. J. Cadogan*¹ and A. M. Finn², ¹Feedworks, Romsey, VIC, Australia, ²DEEDI, Wacol, QLD, Australia.

It is thought poorly digested storage proteins in the sorghum starchy endosperm limit its digestion. In a completely randomized design, individually-housed entire male pigs (Rivalea genotype, n = 126) were selected at 7.8 \pm 1.1 kg, and offered experimental diets for 21 d. Two different sorghum cultivars, a white sorghum Liberty (SL) and red sorghum Buster (SB), with a wheat control (WC), were formulated in at 65% of the diet, and nutritionally balanced using other energy and high quality protein sources. Four increasing levels of Protease (*Bacillus subtilis*, Danisco) were added to the sorghum based diets at 0, 50, 100 and 500ppm. A TiO₂ marker was added to each diet and faeces were collected between d 14 and 16, pooled and sub-sampled for analysis. Over the 0 to 21 d experimental period, pigs offered the WC out performed animals on the SL and SB controls in daily weight gain ($P < 0.05$) by 16.5% and 20.8%, respectively. SL exhibited poorer FCR ($P < 0.05$) than the WC, but feed intakes were similar. The opposite effects were observed for SB. Pigs on the SB control diet ate less ($P < 0.05$) than pigs on the WC but there was no significant difference in FCR. Increasing the protease dose linearly improved FCR ($P = 0.017$) of both sorghums to that of the WC. The SB was measured to be lower in DE compared with the SL and the WC ($P < 0.001$). There was an interaction ($P = 0.048$) between protease and sorghum type, with the enzyme increasing DE for SB but not SL. Both sorghum types depressed the performance of young pigs and the higher protease dose rates improved feed efficiency to the levels of the wheat based diet.

Table 1. Effects of increasing protease dose on two types of sorghum on young pig growth performance compared with a wheat control

Grain type	Protease (ppm)	End Weight (kg)	Daily gain (g/d)	FCR g:g	Daily intake (g)	DE (kcal/kg)
WC	0	16.59 ^a	480 ^a	1.30 ^b	619 ^a	3554 ^a
SL	0	14.92 ^b	401 ^{ab}	1.56 ^a	605 ^{ab}	3554 ^a
	50	15.60 ^{ab}	432 ^{ab}	1.37 ^b	589 ^{ab}	3542 ^a
	100	15.04 ^b	394 ^b	1.43 ^{ab}	559 ^{ab}	3530 ^a
	500	15.77 ^{ab}	435 ^{ab}	1.31 ^b	566 ^{ab}	3520 ^a
SB	0	14.46 ^b	380 ^b	1.43 ^{ab}	535 ^b	3413 ^b
	50	15.37 ^{ab}	413 ^{ab}	1.49 ^{ab}	627 ^a	3415 ^b
	100	14.56 ^b	384 ^b	1.39 ^{ab}	526 ^b	3494 ^a
	500	15.31 ^{ab}	410 ^{ab}	1.33 ^b	536 ^b	3513 ^a
SEM		0.231	9.2	0.023	11.6	10.3

^{ab}Means with unlike superscripts differ ($P < 0.05$).

Key Words: Sorghum, pig, Protease

249 Effect of feeding spring triticale cultivars and low-protein feed wheat on growth performance and nutrient digestibility in weaned pigs. R. Seneviratne^{1,2}, R. Zijlstra², and E. Beltranena*^{1,2}, ¹Alberta Agriculture and Rural Development, Edmonton, Alberta, Canada, ²University of Alberta, Edmonton, Alberta, Canada.

Tyndal and Bunker are new triticale cultivars that there is no information as feedstuffs for swine. The nutritional value of 4 triticale spring cultivars was evaluated in comparison with low-protein feed wheat using weaned pigs. In total, 240 pigs (6.3 \pm 0.94 kg initial BW; 5-wk-old) housed in 60 pens were fed 5 mash diets for 28 d starting 1 wk after weaning for 12 observations per diet. A control diet containing 63% Canada Prairie Spring Red wheat 5700 was formulated to 2.40 Mcal/kg NE and 5.2 g/Mcal NE standardized ileal digestible lysine. Alta, Bunker, Pronghorn, and Tyndal triticale (14.7, 17.8, 15.0, 15.4% CP, DM basis) entirely substituted wheat (12.4% CP) in the test diets. For the entire study (d 0 to 28), ADFI and G:F were not affected ($P > 0.05$) by feeding the triticale cultivars in substitution for wheat. However, feeding Tyndal triticale lowered ($P < 0.05$) ADG by 47 g and these pigs were 1.2 kg lighter ($P < 0.05$) compared with feeding low-protein wheat or Pronghorn triticale. Feeding Pronghorn, Alta or Bunker triticale did not affect ($P > 0.05$) overall ADG or final BW compared with wheat. The apparent total tract digestibility (ATTD) of CP and crude fat did not differ ($P > 0.05$) among diets. Triticale diets had a 3.5% and 3.6% lower ($P < 0.05$) ATTD of DM and GE, respectively, than the wheat control diet. Among triticale cultivars, Pronghorn had the highest ATTD of both DM and GE; Alta, Bunker and Tyndal were similar. Diet affected ($P < 0.05$) the ATTD of Ca and P, but triticale cultivars did not differ from wheat. Pronghorn and Alta triticale had the highest ATTD of Ca, followed by wheat; Tyndal and Bunker had the lowest. Tyndal triticale had lower ATTD of P than wheat and other triticale cultivars. In conclusion, weaned pigs can be fed triticale grain (Bunker, Alta or Pronghorn) in full substitution for low-protein feed wheat.

Key Words: digestibility, growth performance, triticale, weaned pig

250 Artificial sweeteners included in piglets' diet enhance the capacity of their intestine to absorb dietary sugars. A Moran^{*1}, D Batchelor¹, C Ionescu², D Bravo², and S Shirazy-Beechey¹, ¹University of Liverpool, Liverpool, UK, ²Pancosma, Geneva, Switzerland.

A shorter suckling period in piglets leads to several disorders including nutrient malabsorption, diarrhea, malnutrition and dehydration. We have shown that a low concentration of a combination of artificial sweeteners, saccharin and neohesperidin dihydrochalcone (Sucram) included in piglets' diets is effective in enhancing the expression of intestinal glucose transporter, Na⁺/glucose co-transporter, SGLT1 and the gut capacity to absorb glucose (Moran et al. 2010, Brit. J. Nutr. 104:637–646). We determined previously that the sweet taste receptor comprised of T1R2+T1R3 is expressed in intestinal enteroendocrine cells and that dietary sugars and artificial sweeteners act in the intestine, on the sweet taste receptor, and its coupled G-protein gustducin, to activate pathways resulting in upregulation of SGLT1. Our studies in mouse intestine showed that only those artificial sweeteners that activated mouse lingual epithelium sweet taste receptor led to upregulation of intestinal SGLT1. Aim: to determine effects of other artificial sweeteners, sucralose, cyclamate, aspartame and acesulfame K (aceK) on intestinal SGLT1 expression. Five groups of 28 d old piglets (n = 8 per group) were weaned onto a commercial diet lacking any artificial sweeteners, with their drinking water containing either no sweetener, sucralose (2 mM), cyclamate (10 mM), aspartame (1 mM) or aceK (10 mM). All consumed the same amount of food and water. Subsequently, they were sacrificed by euthanasia under ethical permission. Intestinal SGLT1 expression was assessed at levels of mRNA, protein and function. Results: there was a 2.73- ($P = 0.003$), 3- ($P < 0.0001$) and 2.8- ($P = 0.0005$) fold increase in SGLT1 expression in response to inclusion of sucralose, cyclamate and aspartame in the drinking water respectively compared with that in the control. AceK had no effect on SGLT1 expression. Results indicate that intestinal sweet perception in pig is different to some other species. These are due to sequential differences in amino acid residues of sensor proteins interacting with artificial sweeteners, the knowledge of which is essential for designing species-specific sweeteners. The data also highlight the potential of using other artificial sweeteners, having assessed the lowest effective concentrations, as food supplements.

Key Words: SGLT1, Artificial sweetener, Piglet

251 Evaluation of fermentation characteristics and volatile fatty acids production of unique fiber and starch sources using an in vitro model of the pig large intestine. R. Jha* and R. T. Zijlstra, University of Alberta, Edmonton, AB, Canada.

An in vitro model was used to study the fermentation characteristics and VFA production of unique fiber and starch sources, with pectin and inulin as reference. Samples were incubated in a buffered mineral solution inoculated with pig feces. Gas production, proportional to the amount of fermented carbohydrate (CHO), was measured for 72 h; kinetics were modeled. The fermented solution was analyzed for VFA. In Exp. 1, 4 fibers (low fermentable, low viscous cellulose, CEL; low fermentable, high viscous carboxymethylcellulose, CMC; high fermentable, low viscous oat β -glucan, LBG; and high fermentable, high viscous oat β -glucan, HBG) were used. Fermentation kinetics differed ($P < 0.001$) among fiber sources. The LBG and HBG started to ferment sooner (lag time 1.3 and 1.4 h, respectively) than CEL (7.4 h). The fractional rate of degradation was highest ($P < 0.001$) for LBG (0.23/h) followed by HBG (0.19/h) and CEL (0.05/h). Total gas production was highest for CEL (273 mL/g sample) and lowest for CMC

(16 mL/g sample). VFA production was higher ($P < 0.001$) for CEL (7.9) than for LBG, HBG and CMC (7.1, 6.1 and 0.43 mMol/g sample, respectively) with a similar pattern for acetate. Butyrate was highest ($P < 0.001$) for LBG (0.57) followed by HBG and CEL (0.44 and 0.41 mMol/g, respectively). In Exp. 2, 4 starches (S1 to S4, starch sources ranging from rapidly to slowly digestible) were used. Total gas production was highest ($P < 0.001$) with S3 (239) followed by S1, S2 and S4 (237, 226, and 219 mL/g sample, respectively). S4 had the highest ($P < 0.001$) lag time (2.7 h) while S1 to S3 did not differ. The fractional rate of degradation was highest ($P < 0.001$) for S1 (0.19/h), intermediate for S2 and S3 (0.17/h), and lowest for S4 (0.11/h). Starch types did not differ in VFA production (5.8 to 6.0 mMol/g sample). In conclusion, fiber and starch type differ in fermentation characteristics depending on their physico-chemical properties. Thus, specific CHO sources can be used to manipulate fermentation in the pig intestine.

Key Words: fiber, pig, starch

252 Digesta characteristics, plasma metabolites, and short term metabolism of piglets fed a conventional or a supra dose of xylanase in a wheat-based diet. E. Kiarie^{*1}, L. Romero², P. H. Simmins², and C. M. Nyachoti¹, ¹University of Manitoba, Winnipeg, Manitoba, Canada, ²Danisco Animal Nutrition, Marlborough, UK.

Dietary xylanase (XY) has the potential to overcome limitations of fibrous feedstuffs in piglet diets by aiding in the digestibility of the fibrous components. However, understanding the physiological responses of piglets to various doses of XY is important to maximize the value of XY supplementation. The objective of this study was to investigate ileal digesta characteristics (viscosity and VFA concentration), plasma metabolites (urea nitrogen and glucose), and short-term metabolism (respiratory quotient, RQ) of piglets fed wheat based pelleted diets supplemented with XY (Danisco, Marlborough, UK). Diets were: 1) control (CON), 2) control plus conventional level (4,000 U XY/kg of feed; CONX), and 3) control plus supra dose (400,000 U XY/kg of feed; CONSPX); and were formulated to meet NRC 1998 specifications for BW 10–20 kg (phase 1) and 20–50 kg (phase 2). Ninety-six barrows (~7 kg BW) were assigned to 8 pens per diet (n = 4 piglets per pen) based on BW. Each phase lasted for 21 d. Three days before phase termination, pigs were placed in an indirect calorimeter to measure O₂ and CO₂ for determination of RQ, and on d 21, one pig per pen was bled for plasma and sacrificed to sample ileal digesta. Supplemental XY reduced ($P < 0.05$) ileal digesta viscosity of pigs fed CONX and CONSPX diets by more than 30% compared with the CON pigs in both phases. In phase 2, the ileal digesta of CONX pigs had greater ($P < 0.05$) concentration of propionic and branched-chain fatty acids compared with CON, while CONSPX was intermediate. Dietary treatments did not affect ($P > 0.10$) plasma metabolites and short-term metabolism. The RQ was 0.842, 0.932, and 0.935 for CON, CONX, and CONSPX pigs fed phase 1 diets, and 0.916, 0.938, and 0.891 for pigs fed phase 2 diets, respectively. In summary, even though both CONX and CONSPX reduced intestinal viscosity, only the conventional dose of XY increased the production of VFA, which may be a reflection of changes in the intestinal microflora and constitutes an energetic source for the pig intestine.

Key Words: Piglet, Physiological responses, Supra xylanase dose

253 (Invited ASAS Animal Science Young Scholar) Digestibility of dietary fiber in growing pigs. P. E. Urriola* and H. H. Stein, University of Illinois, Urbana, IL.

In vivo and in vitro digestibility experiments were conducted to measure the apparent ileal digestibility (AID) and apparent total tract digestibility (ATTD) of dietary fiber by growing pigs fed fibrous feed ingredients. The objective of Exp. 1 was to measure the digestibility of AA, energy, and total dietary fiber (TDF) when 30% distillers dried grains with solubles (DDGS) was added to a corn-soybean meal diet. Results indicated that the AID of Lys (74.1%) was reduced ($P < 0.05$) in the diet with 30% DDGS compared with the control diet (78.6%), but the AID of most other AA was not affected. The AID and ATTD of energy and TDF were less ($P < 0.05$) in the diet with 30% DDGS (81.0 and 55.5%) than in the control diet (86.0 and 60.0%), but there were no differences in rate of passage or VFA concentration in digesta or fecal samples. The objective of Exp. 2 was to measure the AID and ATTD of TDF in 24 sources of DDGS. On average, the ATTD of TDF in DDGS was 47.3% and varied among sources of DDGS. The ATTD of TDF was correlated to the ATTD of NDF and insoluble dietary fiber ($r^2 = 0.90$ and 0.79 , respectively; $P < 0.05$). In Exp. 3, 5 Light Yorkshire (LY) pigs, 5 Heavy Yorkshire (HY) pigs, and 5 Meishan pigs were fed 5 diets with increasing concentration of soluble dietary fiber. The ATTD of TDF was different ($P < 0.05$) among groups of pigs fed DDGS (Meishan: 75.3%; LY: 39.0%; HY: 55.7%), but the ATTD of TDF was not different when pigs were fed sugar beet pulp, soybean hulls, or pectin. In Exp. 4, a 3-step in vitro digestibility procedure was used to measure the in vitro ATTD of NDF in DDGS. Results indicated that in vitro AID (28.5%) and ATTD (37.5%) of NDF were lower than the in vivo AID (45.9%) and ATTD (59.3%) and it was not possible to predict in vivo ATTD of NDF from the in vitro values ($r^2 = 0.12$). In conclusion, dietary fibers from DDGS are poorly digested by pigs but do not affect the digestibility of other dietary nutrients. The ability of pigs to digest fiber varies with age and breed and there are interactions between breed of pig and the type of fiber. The in vitro procedure that was used in this experiment did not accurately predict in vivo digestibility of TDF.

Key Words: Dietary fiber, Digestibility, Distillers dried grains with solubles, Pigs

254 The effects of feed-withdrawal time on finishing-pig characteristics in a commercial environment. H. L. Frobose¹, N. W. Shelton^{*1}, S. S. Dritz¹, L. N. Edwards¹, K. J. Prusa², M. D. Tokach¹, J. M. DeRouchey¹, R. D. Goodband¹, and J. L. Nelssen¹, ¹Kansas State University, Manhattan, KS, USA, ²Iowa State University, Ames, IA, USA.

Two studies were conducted to determine the effects of feed-withdrawal on finishing-pig carcass composition. In Exp. 1, a total of 728 pigs (BW = 129.9 kg, 10 to 19 pigs/pen) were marketed after being subjected to feed withdrawal times of 7, 24, 36, or 48 h before harvest. As expected, increased feed withdrawal time decreased (quadratic; $P < 0.001$) feed intake. Withholding feed also decreased (linear; $P < 0.02$) live weight, HCW and backfat depth. Percentage yield increased (quadratic; $P < 0.001$) with longer withdrawal periods, as did percentage lean (linear; $P < 0.02$). In Exp. 2, the prevalence of runny bung and leaking ingesta also were recorded to determine whether a relationship existed between feed withdrawal and the incidence of these processing concerns. 843 pigs (BW = 125.5 kg, 16 to 26 pigs/pen) were assigned to feed withdrawal times 7, 12, 24, or 36 h before harvest. Due to misidentification of pigs by plant personnel, data were analyzed from only 25 of 40 pens. Withholding feed tended to decrease (linear; $P < 0.09$) live weight and decreased (linear; $P < 0.001$) feed intake. There were no differences ($P > 0.22$) in HCW, percentage lean, or backfat depth. However, percentage yield (linear; $P < 0.001$) increased with

increasing withdrawal time. Although withholding feed had no effect ($P > 0.31$) on the incidence of runny bung, it did increase (linear; $P < 0.001$) the incidence of leaking ingesta. Overall, withholding feed can be used to avoid weight discounts in heavyweight pigs without negatively impacting carcass composition. However, these advantages come with a potential reduction in carcass weight and increased prevalence of leaking ingesta, resulting in condemned heads at inspection.

Table 1.

Exp. 1	Withdrawal, h					P <	
	7	24	36	48	SEM	Lin	Quad
Wt change, kg	1.2	-1.0	-4.6	-5.4	0.2	0.01	0.01
Feed/pig, kg	6.2	3.7	1.9	1.2	0.2	0.01	0.01
HCW, kg	95.8	95.5	93.8	93.1	0.9	0.02	0.73
Yield, %	74.4	76.1	76.3	76.4	0.23	0.01	0.01
Lean, %	50.7	50.9	51.0	51.0	0.1	0.02	0.31
Exp. 2	7	12	24	36			
Wt change, kg	0.2	-0.1	-2.0	-4.0	0.2	0.01	0.15
Feed/pig, kg	3.5	3.1	1.8	0.6	0.1	0.01	0.93
HCW, kg	91.6	92.9	92.4	91.1	1.3	0.65	0.44
Yield, %	75.3	75.5	76.1	77.0	0.30	0.01	0.77
Runny bung, %	3.3	1.2	6.1	5.1	2.2	0.31	0.78
Leaking ingesta, %	3.3	4.6	9.5	19.5	2.7	0.01	0.36

Key Words: carcass, fasting, feed withdrawal

255 The effects of feeder design and feeder adjustment on the growth performance and carcass characteristics of growing-finishing pigs. J. R. Bergstrom, M. D. Asmus,* M. D. Tokach, S. S. Dritz, J. L. Nelssen, J. M. DeRouchey, and R. D. Goodband, Kansas State University, Manhattan.

Two experiments were performed to evaluate the effects of feeder (conventional dry, 5.8 cm trough/pig, CD vs. wet-dry, 2.9 cm trough/pig, WD) and adjustment on grow-finish pig performance. In both experiments, pigs (PIC 337 × 1050) were fed the same corn-soybean meal diets with 15% DDGS. In Exp. 1, 1,296 pigs (initially 20 kg) were used to evaluate 3 feeder settings for each feeder in a 27-d study. The numbered settings (located in each feeder) were 6, 8, and 10 (~1.8, ~2.4, and ~3.1 cm opening) for the CD feeder and 6, 10, and 14 (1.3, 1.9, and 2.5 cm opening) for the WD feeder. From d 0 to 27, pigs using a WD feeder had similar ADG (0.68 vs. 0.68 kg/d), but lower ($P < 0.02$) ADFI (1.23 vs. 1.26 kg/d) and better G:F (0.55 vs. 0.54) than pigs using a CD feeder. Increased feeder setting improved (linear, $P < 0.01$) ADG (0.59, 0.71, and 0.75 kg/d), ADFI (1.07, 1.28, and 1.34 kg/d), and d-27 BW (35.2, 38.5, and 39.7 kg) of pigs using a WD feeder and increased (linear, $P < 0.01$) ADFI (1.22, 1.26, and 1.30 kg/d) of pigs using a CD feeder. In Exp. 2, 1,248 pigs (initially 33 kg) were used to evaluate 3 feeder settings for each feeder in a 93-d study. The feeder setting treatments were the same for the CD feeder (6, 8, and 10) as in Exp. 1; and 10, 14, and 18 (1.9, 2.5, and 3.2 cm opening) for the WD feeder. Overall, pigs using WD feeder had greater ($P < 0.05$) ADG (0.97 vs. 0.91 kg/d), ADFI (2.64 vs. 2.42 kg/d), final BW (122.4 vs. 116.7 kg), HCW (89.9 vs. 86.9 kg), backfat depth (17.4 vs. 16.3 mm), and feed cost/pig (\$76.28 vs. \$69.87) but reduced ($P < 0.04$) fat-free lean index (FFLI, 49.9 vs. 50.5) compared with pigs using CD feeder. An increased setting of a WD feeder resulted in greater (linear, $P < 0.05$) ADG (0.94 to 1.01 kg/d), ADFI (2.51 to 2.77 kg/d), final BW

(119.3 to 126.1 kg), HCW (87.2 to 92.7 kg), backfat depth (16.9 to 18.3 mm), and feed cost/pig (\$71.92 to \$80.58). When HCW was used as a covariate, FFLI of pigs using a WD feeder decreased (linear, $P < 0.02$; 50.2 to 49.5) with increased feeder opening. An increased setting of a CD feeder had no effect on growth and carcass characteristics. In conclusion, the growth rate of pigs improved with a WD feeder compared with a CD feeder; however, growth of pigs using a WD feeder was more sensitive to differences in feeder adjustment.

Key Words: dry feeder, feeder adjustment, wet-dry feeder

256 (Invited ASAS Animal Science Young Scholar) The effects of a wet-dry vs. a conventional dry feeder, and feeder management strategies, on the growth performance and carcass characteristics of finishing pigs. J. R. Bergstrom,* M. D. Tokach, S. S. Dritz, J. L. Nelssen, J. M. DeRouche, and R. D. Goodband, *Kansas State University, Manhattan.*

Research has shown that ADG and ADFI of finishing pigs may be improved with a wet-dry (WD) feeder compared with a conventional dry (CD) feeder. In a factorial experiment, we found ADG of pigs fed a diet with 60% DDGS using a WD feeder was 5% greater than that of pigs fed a diet with 20% DDGS using a CD feeder. Gilts fed with a WD feeder also had 5% greater ADG than that of barrows fed with a CD feeder. Although greater ADG and ADFI have been observed with a WD feeder, differences in G:F and carcass characteristics have been variable when compared with a CD feeder. Earlier experiments have reported that G:F was either similar or improved with a WD feeder, with no change in percent carcass lean. In recent experiments, we have observed variable responses in G:F and similar or greater backfat depth with a WD feeder. Generally, G:F was improved with a WD feeder in the early grow-finish period. When G:F was poorer with a WD feeder, it usually occurred late in the finishing period, particularly when pigs were fed to a heavier BW. In a series of experiments, we identified WD feeder management strategies that sustained improvements in growth over a CD feeder with similar G:F and carcass traits. Reduced settings of the WD feeder opening usually resulted in improvements in G:F, FFLI, and backfat depth, and reductions in ADG and ADFI. Performance of pigs fed with a CD feeder was not as sensitive to different feeder settings. By providing a more open initial setting for the WD feeder and reducing the setting later in the finishing period, backfat depth and FFLI were improved with minimal reductions in overall ADG and ADFI. Although there were no differences in G:F; ADG, ADFI, and final BW remained greater than that obtained with a CD feeder. In another experiment, switching to a source of water separate from the WD feeder at 4 or 8 wk before market resulted in reduced ADG and ADFI. When the water was switched for the final 8 wk, G:F and backfat depth were improved, but overall ADG was reduced to that obtained with a CD feeder. In conclusion, a WD feeder improved ADG and ADFI, and may be especially beneficial when feeding gilts and/or diets known to reduce ADG. However, differences in the management of a WD feeder had a much greater impact on performance and profitability.

Key Words: dry feeder, feeder adjustment, wet-dry feeder

257 Both weaning weight and post-weaning growth performance affect nutrient digestibility and energy utilization in pigs. C. K. Jones,* R. G. Main, N. K. Gabler, and J. F. Patience, *Iowa State University, Ames, IA, USA.*

Little is known about how dietary energy and nutrient availability changes due to variations in piglet weaning weight or its interaction with post-weaning growth performance. This experiment evaluated the effects of both pig weaning weight category (WW) and post-weaning average daily gain (ADG) on nutrient digestibility and energy utilization. A total of 96 PIC barrows were selected from a population of 960 weaning pigs to represent the 10% lightest, median, and heaviest pigs at weaning ($n = 24$ per WW category; BW = 4.6, 6.2, and 8.1 kg, respectively). Barrows were housed individually and were fed ad libitum quantities of a commercial nursery phase feeding program during a 27-d growth and metabolism study. Total urine and fecal grab samples were collected for 3 d at the end of the experiment for digestibility analyses. At the completion of the study, pigs in each WW category were divided into the slowest, median, or fastest 33% ADG category, yielding a nested design with 9 treatments. The digestibility of dry matter, nitrogen, and gross energy differed ($P \leq 0.01$), resulting in different ($P \leq 0.004$) DE and DE intakes across WW and ADG categories. Pigs with lighter WW and slower ADG within WW category had lower ($P < 0.0001$) energy requirements for maintenance and were more ($P < 0.0001$) efficient at converting energy into gain. Together, these data suggest that both weaning weight and post-weaning growth performance affect nutrient digestibility and nutrient utilization in nursery pigs.

Table 1.

	DM Dig., %	GE Dig., %	N Dig., %	DE, Mcal	DEi, Mcal/d	DEm, Mcal	Energy efficiency for gain, Mcal/kg of gain
Light WW							
–Slow ADG	84.1	85.2	81.3	3.47	1.47	0.76	1.79
–Median ADG	86.4	87.5	84.9	3.56	2.15	0.95	2.34
–Fast ADG	85.9	86.9	84.6	3.54	2.39	1.02	2.40
Median WW							
–Slow ADG	85.1	85.8	81.9	3.50	1.60	0.89	1.18
–Median ADG	86.2	87.4	85.3	3.56	2.49	1.08	2.41
–Fast ADG	84.6	85.8	82.0	3.50	2.96	1.19	2.66
Heavy WW							
–Slow ADG	85.8	86.9	84.1	3.54	2.33	1.05	2.32
–Median ADG	85.9	86.8	84.5	3.54	2.69	1.21	2.34
–Fast ADG	85.4	86.4	84.0	3.52	3.06	1.31	2.39
SEM	0.72	0.70	1.16	0.029	0.135	0.033	0.297

Key Words: Energy, Nutrient digestibility, Pig

Nonruminant Nutrition: Feed and Water Additives

258 Evaluation of a commercial mycotoxin binder (ETX-5™) on performance of growing pigs in a 7-day feeding trial using diets with or without deoxynivalenol (DON) contamination. P. Williams¹ and M. D. Sims*², ¹Feedworks USA Ltd., Cincinnati, OH, ²Virginia Diversified Research Corp., Harrisonburg, CA.

Deoxynivalenol (DON) in corn can inhibit growth and feed efficiency in pigs. A 7-d feeding trial with 80 pigs in 80 pens was conducted using 10 treatments to evaluate performance effects of a commercial mycotoxin binder (ETX-5) at 0, 0.45, 0.91 or 1.81 kg/ton (0B, LowB, MedB, or HiB) in diets contaminated with DON at 0 (0.68 by assay), 1.25 (1.9 by assay), or 2.5 (2.5 by assay) ppm (0.7D, 1.9D, or 2.5D). A completely randomized design was used and ANOVA was performed in 2 sets of 6 treatments each (0B+0.7D and LowB+0.7D with 4 1.9D treatments or with 4 2.5D treatments) (Tukey's; $P \leq 0.05$). Contaminated corn from the US midwest was blended with fresh corn and soybean/trace mineral/vitamin concentrate (ratio of 55.6% corn to 44.4% concentrate) to achieve desired DON levels. Litter mates of 40 barrows and 40 gilts (~10 wk old) of a commercial breed were used. Regarding DON effects, the 1.9D level lowered average daily gain (ADG) (0.64 vs. 0.86 kg; $P > 0.05$) whereas the 2.5D level significantly reduced (0.20 vs. 0.86 kg; $P \leq 0.05$) ADG compared with 0.7D level. Similarly, the 1.9D and 2.5D levels significantly ($P \leq 0.05$) increased feed/gain (F/G) ratios compared with 0.7D level (2.24, 3.13 vs. 7.04 kg/kg). Regarding binder effects, at 1.9D level MedB increased ADG (0.78 vs. 0.64 kg; $P > 0.05$) and significantly lowered F/G (2.34 vs. 3.13 kg/kg; $P \leq 0.05$) compared with 0B. At 2.5D level, each binder level (LowB, MedB, and HiB) significantly ($P \leq 0.05$) improved ADG and F/G compared with 0B. Pigs fed LowB+0.7D diets had significantly higher ADG and lower F/G than 0B+1.9D or LowB+1.9D ($P \leq 0.05$), or 0B+2.5D or LowB+2.5D pigs ($P \leq 0.05$). In conclusion, pigs receiving 1.9 ppm and 2.5 ppm DON contaminated diets supplemented with ETX-5 (0.45, 0.91, or 1.81 kg/ton) had better ADG and F/G ratios than non-supplemented pigs. The 0.91 kg/ton level of ETX-5 supplementation (MedB) was most effective at improving ADG and F/G when pigs were fed DON-contaminated diets (1.9D or 2.5D).

Key Words: deoxynivalenol, DON, mycotoxin binder, vomitoxin

259 Efficacy of feed additives to reduce the effects of chronic exposure to deoxynivalenol and zearalenone on growth and immune status of pigs. A. C. Chaytor*¹, M. T. See¹, J. A. Hansen^{2,1}, D. C. Kendall², T. F. Middleton³, P. R. O'Quinn⁴, and S. W. Kim¹, ¹North Carolina State University, Raleigh, ²Murphy-Brown, LLC, Rose Hill, NC, ³Ag ProVision, LLC, Kenansville, NC, ⁴Prestage Farms, Inc, Clinton, NC.

Five feed additives with potential ability to detoxify mycotoxins were tested to determine the effects on growth and immune responses of pigs fed diets containing deoxynivalenol (DON) and zearalenone (ZEA) from naturally-infected corn for 42 d. Other mycotoxins were not detectable. Gilts (n = 294, 10.4 ± 0.3 kg BW) were allotted to 7 treatments (14 replicates with 7 heavy and 7 light BW pens as a blocking criterion with 3 pigs per pen): PC (positive control with 0.3 mg DON/kg and undetectable ZEA); NC (negative control with 4.8 mg DON/kg and 0.3 mg ZEA/kg); A (NC + yeast cell wall product, 2 g/kg); B (NC + a clay based product, 4 g/kg); C (NC + yeast fermentation metabolites product, 2 g/kg); D (NC + yeast cell wall blend, 1 g/kg); and E (NC + selenium yeast and yeast cell wall blend, 1 g/kg).

Feed intake and BW were recorded weekly, and blood was sampled biweekly. Pigs in NC had decreased BW ($P < 0.05$, 25.7 kg), ADG (0.36 kg) and ADFI (0.72 kg) compared with pigs in PC (30.8 kg, 0.48 kg, and 1.03 kg, respectively). Pigs in NC had increased G:F ($P < 0.05$) compared with pigs in PC (0.51 vs. 0.47). The ADG, ADFI, and G:F of pigs in A, B, C, D, and E were not different ($P > 0.10$) from pigs in NC. However, when compared among light BW groups, ADG and ADFI of pigs in A and C were greater ($P < 0.05$) than pigs in NC. On d 28, pigs in NC had greater ($P < 0.05$) WBC and monocyte counts than pigs in PC, B, and C. Pigs in NC had a reduced ($P < 0.05$) platelet count than all other treatments. On d 42 pigs in NC had reduced ($P < 0.05$) serum protein, serum nitrogen, and serum cholesterol compared with pigs in PC. Serum IgG and tumor necrosis factor α were not affected by dietary treatments. Collectively, feeding diets with 4.8 mg DON/kg and 0.3 mg ZEA/kg to pigs for a 42 d period reduced growth performance and altered some hematological and biochemical parameters. The 5 feed additives varied in their ability to ameliorate challenges associated with DON and ZEA.

Key Words: deoxynivalenol, growth, pigs, zearalenone

260 Effects of ractopamine dose on growth performance traits of finishing pigs raised and marketed under U.S. commercial conditions. M. J. Ritter*¹, K. Cera², N. Paton², and S. N. Carr¹, ¹Elanco Animal Health, Greenfield, IN, ²Akey Nutrition and Research Center, Lewisburg, OH.

This study utilized 72 pens of pigs (n = 1,476; BW = 116 kg) in a randomized complete block design with a 2 × 3 factorial arrangement of treatments to determine the effects of ractopamine (RAC) dose on growth performance traits of finishing pigs that were previously vaccinated or not vaccinated for porcine circovirus type-2 (PCV-2). The treatments were as follows: 1) PCV-2 vaccine treatment (control vs. vaccinated); 2) RAC dose (NRC control vs. RAC at 5 ppm vs. RAC at 7.4 ppm). Pigs were raised under commercial conditions by using wean-to-finish management practices. Pens were stocked with 30 pigs/pen (0.7 m²/pig) at placement. However, the number of pigs in each pen was reduced to 21 (block 1) or 20 pigs/pen (block 2) at d 150 by marketing the heaviest pigs from each pen. After the first group was marketed, pens were weighed and randomly assigned to RAC treatments on the basis of previous PCV-2 vaccine treatment, gender, and live weight. The NRC control diet was formulated to contain lower CP (13.02% vs. 16.03%) and TID Lys (0.67% vs. 0.90%) than the RAC diets. During the 24 d test period, the 7 heaviest pigs in each pen were marketed on d 14, while the remaining pigs in the pen were marketed on d 24. Pen weights were taken on d 0, 14, and 24, while feed disappearance was monitored throughout the 24 d period. Data were analyzed by using Proc Mixed of SAS. There were no RAC dose × PCV-2 vaccine treatment interactions, and thus, only the main effects of RAC dose are discussed. RAC diets were fed for an average of 21 d. Both RAC doses improved ($P < 0.05$) ADG and G:F compared with the NRC control diet, but not ADFI ($P = 0.74$). More specifically, feeding RAC at 5 ppm increased weight gain by 2 kg and improved G:F by 12% over the NRC control diet ($P < 0.05$). Meanwhile, increasing RAC dose from 5 to 7.4 ppm increased weight gain by 1 kg and improved G:F by an additional 5% ($P < 0.05$).

Table 1. Effects of ractopamine (RAC) dose on growth performance traits

Trait	NRC Control	RAC 5 ppm	RAC 7.4 ppm	Pooled SEM	P-Value
Pens	24	24	24	-	-
Initial BW, kg	116.0	115.9	115.9	0.81	0.99
Day 14 BW, kg	128.5 ^a	130.4 ^{ab}	131.1 ^b	0.57	0.03
Final BW, kg ^d	134.7 ^a	136.7 ^b	137.8 ^b	1.19	0.01
BW gain, kg ^d	18.61 ^a	20.74 ^b	21.86 ^c	1.61	0.01
ADG, kg/d ^d	0.90 ^a	1.00 ^b	1.06 ^c	0.08	0.01
ADFI, kg/d ^d	2.75	2.71	2.72	0.12	0.74
G:F ^d	0.33 ^a	0.37 ^b	0.39 ^c	0.01	0.01

^{a,b,c} Means with different superscripts differ ($P < 0.05$); ^d Based on an average of 21 d.

Key Words: pig, ractopamine, growth performance

261 Evaluation of ractopamine HCl feeding methods on growth performance and carcass characteristics of finishing pigs. W. Ying,* J. M. DeRouche, M. D. Tokach, S. S. Dritz, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan.*

A total of 934 barrows and gilts (PIC 337 × 1050, initially 109 kg) were used to evaluate the effect of different ractopamine HCl (RAC) feeding programs on growth and carcass traits of finishing pigs. Treatments were a basal diet with: 1) no RAC for 26 d (control), 2) 7.5 ppm RAC for 26 d (constant), 3) 5 ppm RAC for d 0 to 14 and 10 ppm for d 14 to 26 (step-up), and 4) RAC level increased daily from 5 ppm on d 0 to 10 ppm on 26 d by using the FEEDPro system (curve). Each treatment had 10 pens with approximately equal number of barrows and gilts per pen. From d 0 to 14, pigs fed RAC had greater ($P < 0.01$) ADG and G:F than control pigs. Constant or step-up RAC feeding methods had greater ADFI ($P < 0.04$) than control pigs. From d 14 to 26, pigs on step-up RAC program had greater ($P < 0.005$) ADG and G:F than constant RAC treatment. All RAC-fed pigs had greater ADG ($P = 0.03$) and G:F ($P = 0.0001$) than control pigs. Overall, pigs fed RAC diets had greater ($P < 0.0001$) ADG and G:F than control pigs. In addition, pigs on the step-up RAC program had greater ADG ($P = 0.01$) and G:F ($P < 0.05$) than constant RAC treatment. Pigs fed RAC had heavier HCW ($P < 0.01$) than control pigs. Pigs fed constant RAC had greater yield ($P = 0.002$) than control pigs. Also, pigs fed either constant or curve RAC had greater loin depth ($P = 0.006$) than control pigs. There were no differences ($P > 0.10$) in carcass traits among RAC treatments. In conclusion, feeding RAC improved performance regardless of feeding method but few differences were present between the RAC feeding programs.

Table 1. Effect of RAC feeding methods on growth and carcass traits

		Control	Constant	Step-up	Curve	SEM
d 0-14	ADG, g	829 ^a	1059 ^b	1082 ^b	1089 ^b	38.3
	ADFI, kg	2.45 ^a	2.60 ^b	2.61 ^b	2.49 ^{ab}	0.07
	G:F	0.34 ^a	0.41 ^b	0.42 ^b	0.44 ^b	0.02
d 14-26	ADG, g	888 ^a	995 ^b	1160 ^c	1086 ^{bc}	45.2
	ADFI, kg	2.97	2.79	2.84	2.93	0.09
	G:F	0.30 ^a	0.36 ^b	0.41 ^c	0.37 ^b	0.02
d 0-26	ADG, g	849 ^a	1038 ^b	1110 ^c	1088 ^{bc}	26.8
	ADFI, kg	2.63	2.67	2.69	2.64	0.07
	G:F	0.32 ^a	0.39 ^b	0.42 ^c	0.41 ^{bc}	0.01
	HCW, Kg	91.1 ^a	95.4 ^b	94.7 ^b	94.9 ^b	1.2
	Yield, %	74.3 ^a	75.3 ^b	74.8 ^{ab}	74.8 ^{ab}	0.3
	Loin, cm	6.04 ^a	6.39 ^b	6.20 ^{ab}	6.35 ^b	0.12

^{a,b,c} $P < 0.05$.

Key Words: growth, pig, ractopamine

262 Effect of mix time for diets with ractopamine when fed to finishing pigs. C. B. Paulk,* L. J. McKinney, J. D. Hancock, S. M. Williams, S. Issa, and T. L. Gugle, *Kansas State University, Manhattan.*

Two experiments were completed to determine the effects of mix time for diets with ractopamine HCl (RAC) when fed to finishing pigs. In Exp. 1, 160 pigs (average BW of 93 kg) were fed for 27 d in a completely randomized design (2 pigs/pen and 16 pens/treatment). The control was corn-soybean meal-based with ingredients added to an idle mixer. The mixer was started and the diet mixed for 360 s before discharge. Other treatments were separate batches of that same formulation with 10 mg/kg RAC. Mix times of none, 30, 120, and 360 s before discharge for the diets with RAC yielded CVs of 51, 19, 15, and 12% for the distribution of salt (Quantab assay). Use of RAC improved ($P < 0.01$) ADG, G:F, HCW, loin depth, and percentage carcass lean. However, increasing mix time from none to 360 s for diets with RAC had no effect ($P > 0.19$) on those same response criteria. Means were: 1.08, 1.25, 1.24, 1.29, 1.26 kg for ADG; 288, 329, 322, 342, and 336 g/kg for G:F; 88.5, 92.9, 93.9, 95.1, and 93.9 kg for HCW; 21, 19, 20, 19, and 20 mm for backfat thickness; and 62, 70, 67, 67, and 71 mm for loin depth. In Exp. 2, 200 pigs (average BW of 90 kg) were fed for 33 d in a randomized complete block design (5 pigs/pen and 8 pens/treatment). The control was the same as in Exp. 1 (i.e., corn-soy-based and mixed for 360 s). Other treatments were separate batches of the mixed control with 10 mg/kg RAC added and the batches mixed additionally for none, 30, 120, and 360 s. As for pig growth, RAC improved ($P < 0.01$) ADG, G:F, HCW, dressing percentage, back-fat thickness, loin depth, and percentage carcass lean. Increasing mix time of diets with RAC had no effect ($P > 0.15$) on those same response criteria. Means were: 1.15, 1.20, 1.24, 1.23, 1.25 kg for ADG; 284, 330, 337, 320, and 335 g/kg for G:F; 94.9, 97.4, 99.4, 97.1, and 98.6 kg for HCW; 22, 19, 20, 21, and 19 mm for backfat thickness; and 61, 66, 66, 69, and 68 mm for loin depth. In conclusion, increasing mix time from none to 360 s did not affect the response to RAC in finishing pigs.

Key Words: mix uniformity, ractopamine, finishing pig

263 Supplementing sows with Tri-Lution® decreases fecal shedding of bacteria and improves colostral immunoglobulin concentrations and litter performance. P. K. Brown,* D. A. Spangler, D. M. Albin, D. H. Kleinschmit, D. P. Casper, G. A. Ayangbile, and R. J. Hall, *Agri-King, Inc., Fulton, IL.*

Two experiments were conducted to assess the effects of feeding sows Tri-Lution® (Agri-King, Inc., Fulton, IL) on fecal bacteria populations, colostral immunoglobulins (Ig) (Experiment 1), and litter size and weight at weaning (Experiment 2). In Experiment 1, individually-housed pregnant sows (n = 30) were equally divided, balanced by parity, and allotted randomly to one of 2 dietary treatments from 84 d of gestation until farrowing. Treatments were a basal diet (CON) or basal diet plus 30 g of Tri-Lution® per day (TL). In Experiment 2, individually-housed pregnant sows (n = 128) were allotted to treatments, as described in Experiment 1, from 84 d of gestation until weaning on 22 d of lactation. Data were analyzed as a randomized complete block. In Experiment 1, fecal samples were collected on 112 d of gestation and colostrum was collected within 1 h of birth of the first pig. Fecal coliform ($P < 0.001$; 6.83 vs. 7.46 cfu/g for TL and CON, respectively) and *Clostridium* spp. ($P < 0.05$; 6.75 vs. 7.17 cfu/g for TL and CON) populations were reduced, while beneficial *Enterococcus* spp. were greater ($P < 0.001$; 8.04 vs. 7.42 cfu/g for TL and CON) in sows fed TL. There was also a tendency ($P < 0.10$) for reduced *Salmonella* spp. (6.05 vs. 6.47 cfu/g for TL and CON) in the feces of sows fed TL. Colostral IgA tended to be greater ($P < 0.07$) in sows fed TL. In Experiment 2, the number of live pigs born per sow was not affected by treatment however the live born (19.6 vs. 18.1 kg for TL and CON) and total born weights (21.5 vs. 20.0 kg for TL and CON) from sows fed TL tended ($P < 0.07$) to be greater. The number of pigs weaned per sow was greater ($P < 0.04$) for sows supplemented with TL (11.0 vs. 10.3 pigs for TL and CON), which corresponded to a tendency ($P < 0.09$) for greater litter weaning weight from sows fed TL (69.5 vs. 65.9 kg for TL and CON). In summary, feeding sows Tri-Lution® during the late-gestating period decreased fecal pathogens and tended to increase colostral IgA, which may have contributed to a greater number of pigs weaned per sow.

Key Words: colostrum, fecal bacteria, sow performance, probiotic

264 Actigen improves growth efficiency and immune responses in pigs experimentally infected with porcine reproductive and respiratory syndrome virus (PRRSV). T. M. Che*¹, M. Song¹, R. W. Johnson¹, K. W. Kelley¹, W. G. Van Alstine², K. A. Dawson³, and J. E. Pettigrew¹, ¹*University of Illinois, Department of Animal Sciences, Urbana*, ²*Purdue University, Animal Disease and Diagnostic Laboratory, West Lafayette, IN*, ³*Research, Alltech Biotechnology Center, Nicholasville, KY.*

Mannan oligosaccharide products alter immune responses in pigs challenged with PRRSV. This project tested whether Actigen (a refined yeast-based mannan preparation, Alltech, Inc.) has similar effects. Weaned pigs (n = 64, 21 d old), free of PRRSV, were assigned to 1 of 4 treatments in a 2 × 2 factorial arrangement [2 types of diet: control (0%) and Actigen addition (0.04%); 2 levels of PRRSV: with and without]. Pigs (16/treatment) were penned individually in disease-containment chambers and fed a 4-phase feeding program with declining diet complexity. After 2 wk of an 8-wk period of feeding the treatments, pigs were intranasally inoculated with PRRSV or a sterile medium (Sham) at 5 wk of age. Pig performance, viremia, antibody titer, bronchoalveolar lavage (BAL) cells, and rectal temperature (RT) were measured. Data were analyzed as a randomized complete block design. Infection by PRRSV decreased ADG, ADFI, and G:F throughout the experiment

($P < 0.001$). Actigen did not affect ADG but decreased ($P = 0.047$) ADFI from d 28 to 42 post-inoculation (PI). During that time Actigen increased G:F in challenged pigs but not in Sham (interaction; $P < 0.01$). Actigen did not affect viremia in the infected pigs, but enhanced PRRSV-specific antibody titer at d 35 PI ($P = 0.042$). Actigen increased populations of several subsets of BAL cells at d 7 PI in challenged pigs but not in Sham, with interactions for natural killer cells ($P < 0.01$), cytotoxic T cells ($P = 0.052$), memory/activated T cells ($P = 0.045$), neutrophils ($P = 0.044$), and macrophages ($P = 0.087$). The increases in those immune cells are critical not only in defending against PRRSV, but also in preventing secondary infections. At d 42 PI, populations of T cell subsets ($P < 0.01$), B cells ($P = 0.013$), and macrophages ($P = 0.053$) remained high in the infected pigs, regardless of diet. Infection with PRRSV increased RT of pigs from d 3 to 10 PI ($P < 0.001$) with return to normal at d 14 PI. The RT of pigs was also elevated by Actigen ($P = 0.045$). These findings confirm that Actigen strengthens immune response and efficiency in the face of a PRRSV challenge.

Key Words: actigen, pigs, PRRSV

265 Effects of plant extracts on diarrhea and intestinal morphology of newly weaned pigs experimentally infected with a pathogenic *E. coli*. Y. Liu*¹, M. Song¹, T. M. Che¹, J. A. Soares¹, D. Bravo², C. W. Maddox¹, and J. E. Pettigrew¹, ¹*University of Illinois, Urbana*, ²*Pancosma SA, Geneva, Switzerland.*

A study was conducted to evaluate the effects of 3 different plant extracts (PE) on diarrhea and intestinal morphology of weaned pigs experimentally infected with a pathogenic F-18 *E. coli* (toxins: LT, STb, and SLT-2; 10¹⁰ cfu/3 mL oral dose daily for 3 d). Weaned pigs (n = 64, 6.3 ± 0.2 kg BW, 21 d old) were used in a 2 × 4 factorial arrangement (with or without an *E. coli* challenge; 4 diets (a nursery basal diet (CON), 10 ppm capsicum oleoresin, garlic, or turmeric oleoresin)) and housed in disease containment chambers for 15 d (4 d before and 11 d after the first inoculation (d 0)). The growth performance was measured on d 0 to 5, 5 to 11, and 0 to 11. Diarrhea score (DS; 1, normal, to 5, watery diarrhea) was recorded for each pig daily. Frequency of diarrhea (FD) was the percentage of pig days with DS of 3 or higher. Feces were collected on d 0, 3, 5, 8, and 11 and plated on blood agar to calculate a ratio (RHT) of β-hemolytic coliforms to total coliforms by assessing the populations visually using a score (0, no bacterial growth, to 8, very heavy bacterial growth). On d 5 and d 11, half of the pigs were killed to collect jejunum, ileum, and colon to measure villi height (VH), crypt depth (CD), and their ratio (VH:CD). In the challenged group, the PE treatments reduced ($P < 0.05$) average DS from d 0 to 2 (2.23 vs. 3.43) and from d 6 to 11 (1.50 vs. 3.51) and overall FD (20 vs. 40%), increased ileal VH on d 5 (316 vs. 263 μm), and tended ($P \leq 0.10$) to increase jejunum VH (303 vs. 259 μm) and VH:CD (1.42 vs. 1.15) compared with the CON, but did not affect growth performance and RHT. Garlic enhanced VH:CD (1.60 vs. 1.18) compared with capsicum oleoresin. In the sham group, PE treatments improved ($P < 0.05$) ADG from d 0 to 5 (418 vs. 328 g/d) and reduced average DS from d 3 to 5 (1.49 vs. 2.06) and overall FD (6.7 vs. 20%) compared with the CON. The *E. coli* infection reduced overall ADG, G:F and VH, and increased DS, FD, and RHT as expected. In conclusion, all 3 PE tested reduced diarrhea and increased the villi height of the small intestine of pigs infected with *E. coli*.

Key Words: *E. coli*, plant extracts, weaned pigs

266 Dietary bacitracin (Albac® and BMD®) improves intestinal health in pigs subjected to heat stress. A. J. Moeser*¹, E. L. Overman¹, and D. A. Nelson², ¹North Carolina State University, Raleigh, ²Alpharma, LLC., Bridgewater, NJ.

A total of 48 Yorkshire-cross barrows with an average initial weight of 26.8 ± 0.9 kg were used to determine the effects of heat stress and the addition of dietary Albac (bacitracin zinc) and BMD (bacitracin methylene disalicylate) on ileal and colonic permeability. Within the 3x2 experimental design, pigs were randomly assigned to 1 of 3 experimental diets: non-medicated (Control); 27.5 ppm bacitracin from Albac (Albac) or 33.0 ppm bacitracin from BMD (BMD) and 2 environmental temperatures: constant 22°C (Thermoneutral) or 12 h/d at 36°C and 12 h/d at 29°C (Heat-Stress). All pigs were acclimated to their respective treatment diets and rooms at 22°C for 5 d, followed by 10 d of dietary treatments and environmental temperature regulation. Feed intake was restricted to 85% of expected ad libitum feed intake. On d 15 of the experiment, all pigs were killed. Ileum and proximal colon samples were collected and mounted on Ussing chambers to measure intestinal permeability via transepithelial electrical resistance (TER) and mucosal-to-serosal flux of FITC-Dextran, 4 kDa (FD-4 flux). Heat-Stress reduced ($P < 0.05$) colon TER (TER, $\Omega \cdot \text{cm}^2 = 89 \pm 10$ and 43 ± 4 for Thermoneutral and Heat-Stress pigs, respectively) and increased ($P < 0.01$) FD-4 flux in the ileum (% FD-4 flux = 42 ± 7 and 81 ± 20 for Thermoneutral and Heat-Stress pigs, respectively) and colon (% FD-4 flux = 8.9 ± 2 and 57 ± 10 for Thermoneutral and Heat-Stress pigs, respectively) indicating intestinal damage. Pigs fed either Albac or BMD in the Heat-Stress environment had higher ($P < 0.05$) colon TER than Control pigs (TER, $\Omega \cdot \text{cm}^2 = 43 \pm 4$, 66 ± 7 , and 62 ± 4 , for Control, Albac and BMD, respectively) and lower ($P < 0.05$) intestinal FD-4 flux (% FD-4 flux = 57 ± 10 , 41 ± 9 , and 20 ± 8 for Control, Albac and BMD, respectively). These data demonstrate that Albac and BMD reduce intestinal barrier injury that results in pigs exposed to heat stress. As a result, pig performance may be enhanced by feeding Albac or BMD during the summer months when environmental temperatures are typically elevated. Albac® and BMD® are registered trademarks of Alpharma, LLC, Bridgewater, NJ

Key Words: heat stress, intestinal health, bacitracin, swine

267 The effect of chlorine dioxide (ClO₂) in drinking water on the growth of pigs. K. C. Turner*¹, J. E. Link¹, S. J. Bursian¹, G. M. Hill¹, B. E. Straw¹, B. S. Gay², and D. W. Rozeboom¹, ¹Michigan State University, East Lansing, ²NEO Products, Holly, MI.

A total of 294 pigs (Yorkshire x [Yorkshire x Landrace] and Duroc x [Yorkshire x Landrace]; initially 6.2 kg BW) were used to determine: 1) if ClO₂ in the drinking water improves growth performance of from 3 to 9 wk of age; 2) if exposure to ClO₂ in the drinking water is potentially toxic; and 3) if finishing growth performance is affected by the inclusion of ClO₂ in nursery drinking water. At weaning, pigs were blocked by wt and allotted by litter and sex to the 3 experimental treatments: 1) control, 2) ClO₂ in drinking water at 25 mg/L, or 3) antimicrobial (carbadox) in the diet at 55 ppm. Pharmacological dietary concentrations of Cu and Zn were not used. Twenty-one pens and 7 pigs per pen were used in each of 2 replicates. Blood was collected by vena puncture from 3 randomly-selected pigs/pen on d 0 and 42 of the treatment period, and from 12 randomly-selected pigs per treatment group 30 d post-nursery treatment, for determination of hemoglobin and thyroid hormone concentrations, and red blood cell glutathione peroxidase (GSH-Px) activity. After the nursery treatment period, pigs were mixed, moved to grow-finish rooms, and reared similarly until marketing. During the 42-d nursery period, there were no differences in ADG, ADFI or F/G between treatments, overall or in any of the 4 dietary phases (4, 7, 14, and 17 d, respectively). Hemoglobin concentration, GSH-Px activity, and total thyroxine, total triiodothyronine, free thyroxine, and free triiodothyronine concentrations did not differ among treatments at any sampling time. Pigs receiving ClO₂ or carbadox in the nursery were heavier than control pigs after 91 d of the finishing period ($P < 0.01$; 96.8, 97.0 and 92.4 kg, respectively). In the nursery, growth of pigs was unaffected by the inclusion of ClO₂ in drinking water and there was no hematological evidence of toxicity. However, results suggest that treating nursery drinking water with ClO₂ may improve growth of pigs later during the finishing period.

Key Words: nursery pigs, chlorine dioxide, pig growth

POSTER PRESENTATIONS

Odor and Nutrient Management

268 Evaluation of a commercial ozone treatment system to reduce swine slurry odor. A. R. Omer* and P. M. Walker, *Illinois State University, Normal, IL.*

Development of a technology that can reduce the odor of liquid swine manure during agitation and land application could prove beneficial to the swine industry. The purpose of this study was to evaluate the Smart Earth Technology®(SET) ozone treatment system for swine slurry under production scale conditions. The facility used for this study was a curtain sided finishing building housing 500 grow-finish market hogs located over a manure pit measuring 12.2m × 25.9m × 2.4m with a total pit capacity of 770,142 l, containing 577,607 l. The SET system exposes air to UV light creating O₃. The O₃ is then injected into slurry at a rate of 378.5l/min. treating 22,712l/h. In this study the entire pit contents were treated every 25.4h. At 0, 24, 48, and 96h 2 slurry samples were collected with a 3.05m probe and 6 air sample bags were col-

lected via a vacuum pump. No significant differences were detected in slurry samples between time periods. Mean slurry values were 13.6 ± 4.6% solids dry wt., 850 ± 70mg/l settleable solids, 54,200 ± 4,384mg/l total suspended solids, 61,050 ± 12,657mg/l chemical oxygen demand, 0.86 ± 0.14%N, 0.49 ± 0.27%P, 0.45 ± 0.01%K and dissolved oxygen below detection limits. Ammonia concentrations decreased ($P = 0.004$) from 0 to 96h. Odor panelists analyzed air samples for intensity at recognition(IR), offensiveness at recognition(OR), intensity at full strength(IFS) and offensiveness at full strength(OFS). Panelists found OR, IFS and OFS were reduced ($P < 0.01$) at 48 and 96h compared with 0h and IR was reduced ($P < 0.04$) at 24 and 48h but not at 96h but trended lower ($P = 0.12$) at 96h. The SET system significantly improved air quality within the building suggesting that odor emanating from swine buildings and odor generated during land application of slurry should be reduced when treated with the SET system.

Key Words: swine slurry, odor, treatment

Physiology

269 Effects of estradiol-17 β treatment on the specific activity of kallikrein in ovariectomized ewes. L. A. Lekatz*¹, J. S. Haring², C. O. Lemley¹, G. P. Dorsam², and K. A. Vonnahme¹, ¹*North Dakota State University, Center for Nutrition and Pregnancy, Department of Animal Sciences, Fargo,* ²*North Dakota State University, Department of Chemistry and Biochemistry, Fargo.*

Kallikrein, a serine protease, liberates bradykinin and kallidin to elicit vasodilation. We hypothesized that estradiol-17 β (E₂) would increase the specific activity (SA) of kallikrein in uterine flushings (UTF) and endometrial explant culture media (ECM). To examine the effect of E₂ on the SA of kallikrein in UTF and ECM, 25 ovariectomized ewes were implanted with 100 mg of E₂ for 0, 12, or 48 h. The uterus was flushed with PBS, placed on ice, and transported to sterile conditions for explant culture studies. Caruncles were dissected and placed in medium and incubated on a rocking platform at 37°C for 24 h. Protein concentration of UTF and ECM samples was determined using the Bradford assay. Kallikrein activity was determined by adding the fluorescent substrate, Pro-Phe-Arg-7-amido-4-methylcoumarin to UTF and ECM samples. Fluorescent units were obtained at 0, 2, 4, 6, 8, 10, 15, 20, 25, 30, and 60 min after substrate addition. The SA was determined by using the initial linear portion of the curve obtained from fluorescent units divided by the protein concentration of the sample. In UTF there was an overall linear effect ($P < 0.01$) of E₂ on protein concentration (0.26, 1.81, and 3.18 ± 0.83 mg/mL for 0, 12, and 48 h, respectively). Treatment with E₂ did not alter ($P = 0.40$) protein concentration in ECM (mean 14.79 ± 2.10 mg/mL). There was no effect of E₂ ($P \geq 0.12$) on kallikrein fluorescent units in UTF or ECM. In UTF there was a quadratic effect ($P = 0.02$) of E₂ on kallikrein SA. After 12

h of E₂ exposure, kallikrein SA decreased ($P = 0.03$) compared with 0 h E₂ (312 vs. 28.7 ± 74 $\mu\text{mol min}^{-1}/\text{mg}$). Kallikrein SA remained lower after 48 h of E₂ exposure, but was similar ($P = 0.30$) to 12 h of E₂ exposure (128 ± 58.0 $\mu\text{mol min}^{-1}/\text{mg}$). In ECM there was a tendency for a quadratic effect ($P = 0.06$) of E₂ treatment on kallikrein SA. After 12 h of E₂ exposure, kallikrein SA increased ($P = 0.05$) compared with 0 h of E₂ (119 vs. 307 ± 55.5 $\mu\text{mol min}^{-1}/\text{mg}$). After 48 h of E₂ exposure, kallikrein SA remained greater ($P = 0.05$) than 0 h of E₂, but was similar ($P = 0.99$) to kallikrein SA at 12 h (306 ± 55.5 $\mu\text{mol min}^{-1}/\text{mg}$). Exposure to E₂ stimulates kallikrein SA in isolated caruncular tissue, indicating a potential role of kallikrein in vascular reactivity of the developing placenta.

Key Words: Estradiol-17 β , kallikrein, sheep, uterus

270 Effects of maternal diet on age of puberty and uterine and ovarian characteristics in adolescent offspring in sheep. K. A. Vonnahme,* T. L. Neville, J. S. Caton, D. A. Redmer, L. P. Reynolds, and A. T. Grazul-Bilska, *North Dakota State University, Fargo.*

To examine the effects of maternal Se supplementation and total nutrient intake on age of puberty and uterine and ovarian characteristics in ewe lambs at 6 mo of age, pregnant Rambouillet ewes (n = 82) were randomly assigned to either an adequate Se diet (ASe; 9.5 $\mu\text{g}/\text{kg BW}$) or a high Se diet (HSe; 81.8 $\mu\text{g}/\text{kg BW}$) at breeding. On d 50 of gestation ewes were randomly assigned to receive: 60% (R), 100% (M), or 140% (E) of NRC requirements. Immediately after birth, lambs were separated from their dams and given artificial colostrum for 20 h,

followed by milk replacer. Blood samples were collected weekly for presence of progesterone from 99.4 ± 0.6 d of age to harvest at 180.1 ± 0.4 d of age. Reproductive tissues were collected at harvest. Age at puberty was not affected by maternal diet, however lambs from ASe ewes had an increased ($P = 0.05$) area under the curve for progesterone compared with lambs from HSe ewes. Proportion of ewes with progesterone concentration greater than 0.4 ng/ml at 6 mo of age was greater ($P < 0.06$) in HSe than in ASe group (96% vs. 75%). Maternal diet did not affect uterine characteristics but ovarian weight tended ($P < 0.08$) to be greater in lambs from dams fed HSe than ASe. Maternal diet did not affect ($P = 0.41$) the labeling index of secondary, early antral or atretic follicles, and corpora lutea. However, the labeling index in granulosa and theca of antral follicles tended to be greater ($P < 0.07$) in lambs of ASeM compared with the other groups. Our results demonstrate that maternal diet influenced fetal ovarian but not uterine characteristics, although, diet did not affect timing of puberty. These results indicate that maternal plane of nutrition may affect reproductive function in offspring.

Key Words: maternal nutrition, ovary, puberty

271 Prenatal heat stress effects on male mouse fertility. A. T. Desaulniers,* W. R. Lamberson, and T. J. Safranski, *University of Missouri, Columbia.*

The primary cause of profit loss in swine production is reproductive failure. Previous research has shown sows heat stressed during gestation have male progeny with shorter anogenital distance (AGD) than those housed thermoneutrally; in rats reduced AGD is associated with demasculinization. The objective of this study was to evaluate the effect of prenatal heat stress on birth AGD and fertility, and to evaluate use of a 5% w/v decoction of *Artemisia absinthium* (AA) to mitigate heat stress effects. Pregnant mice ($n = 58$) were housed in ambient temperatures of either $34 \pm 1.5^\circ\text{C}$ (heat stress, HS) from d 10–18 of gestation for 12 h daily with ad lib access to water (HSW), HS with ad lib access to AA from d 5–18 (HSA), $21.8 \pm 1^\circ\text{C}$ (thermoneutral, TN) with ad lib access to water (TNW) or TN with AA (TNA). Fluid consumption and litter size of dams and weight and AGD of progeny were recorded. High and low AGD ratio (AGD: wt) males were selected from each litter and mated to non-littermate females from each treatment group; these females were sacrificed after 16 d of TN gestation. Ovulation rate and number of fetuses present were compared among all male/female treatment combinations. Daily fluid consumption was elevated in HSA and HSW treatments (23.5 ± 1.4 g and 20.9 ± 1.4 g) compared with TNA and TNW (19.3 ± 1.4 g and 16.5 ± 1.4 g ($P = 0.0156$)). Offspring born to HSW females had the shortest AGD at birth, 1.17 ± 0.03 mm ($P < 0.0001$). Birth AGD ratio was highest in HSW progeny, followed by TNW, HSA and TNA, respectively ($P < 0.0001$). Progeny from HSA were heaviest at weaning ($P < 0.0001$) followed by TNW, HSW and TNA. Weaning AGD ratio was highest in TNA ($P < 0.0001$) followed by HSW, TNW and HSA. Testes weight, ovulation rate and number of fetuses did not differ across treatments. Fertility measures examined in this study were not affected by prenatal heat stress. These data indicate in utero heat stress decreases birth AGD and AA decoctions mitigate that effect.

Key Words: anogenital distance, artemisia absinthium, fertility, prenatal heat stress

272 Effects of dietary selenium and nutritional plane during gestation on placental size at term and serum growth hormone in

ew lambs during pregnancy and lactation. C. O. Lemley*¹, A. M. Meyer¹, T. L. Neville¹, D. M. Hallford², D. A. Redmer¹, L. P. Reynolds¹, J. S. Caton¹, and K. A. Vonnahme¹, ¹*North Dakota State University, Fargo,* ²*New Mexico State University, Las Cruces, NM.*

Objectives were to examine effects of Se supply, maternal nutritional plane and offspring sex during gestation on placental size at term and maternal GH concentrations during pregnancy and lactation. Rambouillet ewe lambs ($n = 84$) were allocated to treatments that included Se supply of adequate Se (ASe, 11.5 $\mu\text{g}/\text{kg}$ BW) or high Se (HSe, 77 $\mu\text{g}/\text{kg}$ BW) initiated at breeding and nutritional plane of 60% (RES), 100% (CON), or 140% (HIGH) of requirements starting at d 40 of gestation. At parturition ewes were transitioned to a common diet that met requirements of lactation. From a subset of ewes ($n = 42$) blood samples were taken during gestation, parturition, and lactation to determine GH concentrations. Total placental weight and intercotyledon weight were similar between treatments ($P > 0.2$). Placental efficiency (the ratio of birth weight to placental weight) tended ($P = 0.1$) to be reduced in HSe compared with ASe ewes. A Se by offspring sex interaction ($P = 0.03$) was detected for cotyledon weight at term, where cotyledon weight was greater ($P = 0.01$) for ASe ewes carrying male vs. female offspring, while cotyledon weight was intermediate for HSe ewes irrespective of offspring sex. Cotyledon number was reduced ($P = 0.03$) in RES and HIGH compared with CON ewes. Placental delivery time tended ($P = 0.07$) to be shorter in HSe compared with ASe ewes, while placental delivery time was longer ($P = 0.02$) in RES compared with CON and HIGH ewes. During gestation and lactation maternal GH was reduced ($P < 0.02$) in HIGH compared with CON and RES ewes. During gestation maternal GH was increased ($P < 0.01$) in dams gestating male vs. female fetuses. A nutrition by Se by h interaction ($P < 0.01$) was detected for GH concentrations during parturition, where ASe-RES ewes were elevated at 3 h following parturition compared with other treatment groups. In conclusion, maternal nutritional plane impacted cotyledon number at term and GH concentrations during pregnancy and lactation, while increasing Se supply during gestation tended to decrease placental efficiency. In addition, both Se supply and nutritional plane altered placental delivery time.

Key Words: growth hormone, placenta, selenium

273 Neonatal hormone changes and percent weight change in lambs born to dams receiving differing Se levels and dietary intakes during gestation. L. E. Camacho,* A. M. Meyer, T. L. Neville, C. J. Hammer, D. A. Redmer, L. P. Reynolds, J. S. Caton, and K. A. Vonnahme, *North Dakota State University, Fargo.*

To investigate effects of maternal Se supplementation and dietary intake during gestation on neonatal hormone changes and percentage BW change in lambs, 84 first parity Rambouillet ewes were allocated to a 2×3 factorial arrangement: Se levels [adequate Se (ASe, 11.5 $\mu\text{g}/\text{kg}$ of BW) or high Se (HSe, 77.0 $\mu\text{g}/\text{kg}$ of BW)] initiated at breeding and nutritional intake [60% (restricted, RES), 100% (control, CON), or 140% (high, HIGH) of requirements] initiated at d 40 of gestation. After parturition, all lambs were removed from their dams, fed common diets, and weights and blood samples were collected on d 0, 1, 3, 7, 14, and 19. There was a Se \times nutritional intake \times day interaction ($P < 0.01$) for percentage BW change. Lambs born to ASe-HIGH ewes had a decreased ($P \leq 0.07$) BW change compared with ASe-CON and ASe-RES groups on d 7. Lambs from HSe-HIGH ewes had increased ($P \leq 0.07$) BW change compared with HSe-RES and HSe-CON from d 7 to 19. At birth, there was a Se \times sex of offspring interaction ($P = 0.03$) where male lambs from HSe ewes had decreased cortisol com-

pared with all other lambs. While there were no differences in thyroxine (T4) at birth, male lambs from CON ewes had increased ($P < 0.05$) triiodothyronine (T3) compared with all other lambs. By 24 h, lambs from RES ewes had decreased ($P = 0.04$) cortisol compared with those from HIGH, with lambs from CON ewes intermediate. Moreover, male lambs had less ($P = 0.04$) cortisol at 24 h compared with females. Lambs from RES- and CON-fed ewes had greater ($P = 0.03$) T4 values than HIGH. Serum hormone concentrations differed ($P < 0.08$) among sex and sampling days during the postnatal period where by d 3, male lambs had increased ($P < 0.01$) T3, reduced ($P = 0.02$) cortisol, and similar ($P = 0.61$) T4 to females. On d 7, females had greater ($P < 0.09$) concentrations of T4 than did males. Thereafter, T3, T4, and cortisol were similar ($P > 0.17$) among lambs regardless of sex or maternal nutritional status. Alterations in the endocrine profile of lambs resulted from maternal dietary treatments and may impact postnatal growth and development.

Key Words: cortisol, maternal nutrition, selenium, thyroid hormones

274 Intracellular signaling cascades induced by relaxin in the stimulation of capacitation and acrosome reaction in fresh and frozen-thawed bovine spermatozoa. A. G. Miah*¹, U. Salma¹, M. Hölker¹, D. Tesfaye¹, H. Tsujii², and K. Schellander¹, ¹University of Bonn, Institute of Animal Science, Bonn, Germany, ²Shinshu University, Interdisciplinary Graduate School of Science and Technology, Nagano, Japan.

Relaxin is one of the 6-kDa peptide hormone acts as a pleiotropic endocrine and paracrine factor. Our previous studies revealed that

the supplementation of relaxin into the sperm capacitating medium induced capacitation and acrosome reaction (AR) potentially in fresh and frozen-thawed porcine or bovine spermatozoa. However, the intracellular signaling cascades induced by relaxin in the stimulation of sperm capacitation or AR were unknown. Therefore, this study was undertaken to investigate the intracellular signaling cascades involved with capacitation and AR induced by relaxin in fresh and frozen-thawed bovine spermatozoa. Spermatozoa were incubated in sperm Tyrode's albumin lactate pyruvate (Sp-TALP) medium supplemented with (40 ng/ml) or without relaxin, and subjected to evaluate the chlortetracycline staining pattern, cholesterol efflux, calcium influx, intracellular cyclic adenosine monophosphate (cAMP) and protein tyrosine phosphorylation. Capacitation and AR were increased ($P < 0.05$) in both fresh and frozen-thawed spermatozoa incubated with relaxin. The fresh and frozen-thawed spermatozoa incubated with relaxin resulted in the release of greater ($P < 0.05$) contents of cholesterol than that of the spermatozoa incubated without relaxin. The fluxes of calcium into the fresh and frozen-thawed spermatozoa were stimulated ($P < 0.05$) by relaxin. The Sp-TALP medium containing relaxin increased ($P < 0.05$) the production of intracellular cAMP, and exhibited higher ($P < 0.05$) exposure of protein tyrosine phosphorylation in both spermatozoa than the medium devoid of relaxin. Thus, the results postulate that relaxin exerts the intracellular signaling cascades involved with capacitation and AR through accelerating the cholesterol efflux, calcium influx, intracellular cAMP and protein tyrosine phosphorylation in fresh and frozen-thawed bovine spermatozoa.

Key Words: relaxin, intracellular signaling cascades, capacitation and acrosome reaction, fresh and frozen-thawed bovine spermatozoa

Tuesday, March 15, 2011

SYMPOSIA AND ORAL SESSIONS

Physiology Symposium: Factors Influencing Female Reproductive Efficiency

275 (Invited) Advancement in understanding the central pathways that underlie the effects of exteroceptive signals on the gonadotropic axis of the female for initiation of puberty and maintenance of normal reproductive cycles. C. A. Lents,* *USDA-ARS U.S. Meat Animal Research Center, Clay Center, NE.*

Neural circuits within the brain regulate the proper temporal release of GnRH from hypothalamic neurons for the initiation of puberty and maintenance of normal reproductive cycles in the female. This process involves feedback from gonadal steroids and is metabolically gated. Full understanding of how these mechanisms are controlled, and the ability to manipulate them in domestic animals, remains elusive. Recent studies have demonstrated that RFamide peptides, such as kisspeptin and gonadotropin-inhibitory hormone (GnIH) play a critical role in this progression. Kisspeptin is a potent stimulator of LH secretion due to its direct action on GnRH cells. Kisspeptin neurons express estrogen receptor and expression of kisspeptin mRNA in the hypothalamus changes with pubertal development and stage of the reproductive cycle. Gonadotropin-inhibitory hormone acts at the hypothalamus and pituitary gland to suppress secretion of LH. It has been implicated in control of the ovulatory surge of LH but the role of GnIH in pubertal development is not well established. Expression of GnIH is observed in areas of the hypothalamus that have important roles in regulating feeding behavior. Kisspeptin is a target for leptin signaling and may integrate metabolism with reproductive function. The recently identified adipocyte factor nesfatin-1 regulates feed intake and may additionally link metabolic state with the gonadotropic axis for the initiation of puberty through its effects at the hypothalamus. Advancing our understanding of how these central pathways function to control puberty is expected to lead to new strategies to increase gonadotropin secretion and minimize the number of replacement females that fail to reach puberty within acceptable production cycles.

Key Words: gonadotropin-inhibitory hormone, luteinizing hormone, kisspeptin, puberty

276 (Invited) The oocyte molecular phenotype: Influence of the follicular environment and body condition. J. R. Wood,* *University of Nebraska, Lincoln.*

In both beef and dairy cows low pregnancy rates (60–70% and 35–55%, respectively) have been largely attributed to embryonic loss. Studies indicate that oocyte quality, in addition to developmental and uterine defects, is a significant factor contributing to embryonic loss. Oocyte quality is established during follicular growth and is dependent on the acquisition of nuclear and cytoplasmic factors which are required for the completion of meiosis, fertilization, and early embryonic development. The goal of our research is to understand how the follicular environment, which is likely dependent on inherent properties of the ovary and can fluctuate upon environmental challenges, regulates the

molecular phenotype of the oocyte. To attain this goal, our laboratory uses a model of beef cow fertility which uses culling age due to pregnancy failure to identify animals with low, moderate, and high fertility. Interestingly, animals in the low fertility group exhibit lower surface antral follicle counts, smaller ovarian size and increased follicular fluid androstenedione levels compared with moderate or high fertility cows. Mural granulosa cell gene expression is also different between the 3 fertility groups. Taken together, these data suggest differences in the follicular environment of the low, moderate and high fertility animals. We have demonstrated that cumulus-oocyte complexes collected from the dominant follicle of these same animals exhibit fertility group-dependent differences in gene expression indicating that the follicular environment influences this molecular phenotype. In addition to this cow model, our group also uses a mouse model to examine how changes in body condition alter the follicular environment and oocyte quality. Specifically, the affect of fluctuations in adipokine levels associated with increased visceral fat mass on granulosa cell gene expression, cumulus-oocyte communication, and oocyte nuclear and cytoplasmic maturation is being studied. Together, these complementary studies have begun to identify mechanisms that may regulate the development of an oocyte with good versus poor quality. Understanding these mechanisms may have important implications for the management of animals used for breeding as well as the reproductive technologies used to maximize reproductive performance.

277 (Invited) Pregnancy losses in domestic animals. D. L. Davis,* *Kansas State University, Manhattan.*

It has long been recognized that fertilization failure, embryonic loss, and fetal death occur in mammals. A potential conceptus (PC) is defined as an ovulated egg that is exposed to the potential for development into a neonate. A PC is the only chance for pregnancy in monotocous species. In litter species, both individual PC loss and the loss of the entire litter are observed. Losses due to fertilization, embryonic, and fetal failures occur in all species but it is accepted that the embryonic period represents a major interval of loss in all mammals. Situations exist where failed fertilization accounts for less than 10% of PC and fetal death can also be small. However losses in the fetal period are costly in monotocous species due to their effect on nonproductive days. A substantial basal loss in the embryonic period is a common feature across species. Considerable resources have been directed at understanding the embryonic period and much has been learned. However basal embryonic loss remains an unsolved mystery of reproductive biology. This review will consider multiple species and the effects of current management practices on losses of PC.

Key Words: pregnancy, fertilization, embryo, fetus

278 (Invited) Transgenic alteration of milk composition and milk performance in livestock. M. B. Wheeler,* *University of Illinois, Urbana.*

The introduction of specific genes into the genome of farm animals and its stable incorporation into the DNA has been a major technological advance in agriculture. Transgenic technology provides a method to rapidly introduce “new” genes involved in milk production and milk synthesis into cattle, swine, sheep, and goats without crossbreeding. Methods to produce transgenic animals have been available for more than 20 years yet recently lines of transgenic livestock have been developed that have the potential to improve animal agriculture and benefit producers and/or consumers. The use of gene transfer technology to produce transgenic livestock can profoundly impact milk production. Practical applications of transgenesis in lactation and production include improved milk production and/or composition, increased lactation performance, and the production of nutraceuticals or biopharmaceuticals in milk. One practical application of transgenics in livestock production is to improve milk production and/or composition. For example, sow milk yield and composition are key limiting factors to preweaning piglet growth and consequently to postweaning growth. To address this issue of low milk production, transgenic swine overexpressing the milk protein bovine α -lactalbumin were developed and characterized. The outcomes assessed were milk composition, milk yield, and piglet growth. Our results indicate that transgenic overexpression of milk protein may provide a means to improve swine lactation performance.

Key Words: alpha-Lactalbumin, mammary gland, milk, transgenic animals

279 (Invited) Influence of metabolic pathways on dam longevity. L. A. Rempel,* *USDA, ARS, USMARC, Clay Center, NE.*

Metabolism is an ever-changing dynamic system that can influence various physiological conditions including reproductive performance. It has been established that use of caloric restriction can enhance lifespan. But, it is also a well known fact that high energy demands in tandem with moderate to low feed intake, can reduce reproductive capabilities. Swinging wildly to the other end of the pendulum, excessive weight gain can have detrimental effects on longevity and reproduction as well. Recent reports in human studies have coined the phrase “skinny fat” otherwise known as normal weight obesity in which slender framed people have excessive visceral fat altering their hepatic metabolism to reflect an obese environment. It is not out of the norm to expect similar variation within livestock species. Genetic

selection within the dairy industry for milk yield has had a negative impact on fertility, reducing dam stayability. Similarly in the swine industry, peripartal energy demands can have a detrimental effect on weaning-to-estrus interval and reproductive performance post-weaning. Researchers are investigating alterations to metabolites during strenuous phases to better understand the relationship of metabolism and fertility. This presentation will highlight some of the current work being conducted in cattle, swine, rodent, and human studies to better ascertain the alterations in metabolic pathways and their impact on longevity from a reproductive standpoint. Obviously variation in body condition exists and cannot be the end all, be all for estimates on dam longevity. But, rather these components used in tandem with genomic, gene expression, and applied studies will potentially provide useful measures to identify females that will have an innate opportunity to withstand nutritional insult while maintaining reproductive values contributing to dam longevity.

Key Words: metabolism, dam longevity, reproduction

280 (Invited) Economic returns at varying levels of reproductive efficiency. K. Dhuyvetter,* *Kansas State University, Manhattan.*

In recent years many sectors of the livestock industry (e.g., beef, dairy, and swine) have experienced severe financial stress over extended time periods due to extremely volatile markets (prices of both outputs and inputs). As a result, there is a lot of focus and discussion regarding the importance and value of risk management to ensure economic sustainability of livestock operations. However, considerable research has shown that managing year-to-year price risk, which is a significant risk for livestock producers, is difficult to do effectively with existing risk management tools. Thus, one of the best means producers have for managing risk to ensure long-term business survival is by being a low-cost producer, i.e., produce output at the lowest cost per unit as possible, while maintaining the quality of the product such that it is readily marketable. One of the most important methods of being a low cost producer is to have high production, which begins with reproductive efficiency. While reproductive efficiency can be defined several ways, from an economic standpoint it basically refers to using an asset (e.g., cow, sow) in an efficient manner such that the costs of obtaining the asset (i.e., purchase cost or development cost) are allocated over as much production as possible. This presentation will review the impact varying key reproductive efficiency measures have on costs of production and economic returns for the beef, dairy, and swine industries through the use of projected budgets and simulations.

Key Words: economic returns, low cost, projected budgets

SYMPOSIA AND ORAL SESSIONS

Physiology

281 (Invited ADSA Young Dairy Scholar) Pyruvate carboxylase: A coordinator of energy metabolism. H. M. White* and S. S. Donkin, *Purdue University, West Lafayette, IN.*

Pyruvate carboxylase (PC) is a key regulator of gluconeogenesis from lactate and maintenance of TCA cycle intermediates. The bovine PC gene contains 3 promoters (P3, P2, and P1; 5' to 3') that produce 6 5' untranslated region (UTR) mRNA variants. The products of promoter 1 are specific to glucogenic and lipogenic tissues. The objective of this work was to examine expression of UTR variants during heat stress, transition to lactation, and negative energy balance, physiological states that alter PC mRNA expression, to understand the mechanisms controlling PC gene promoter function. Liver biopsies were collected from multiparous Holstein cows on -28, +1, and +28 d relative to calving (n = 8), and from mid-lactation cows fed for either ad libitum intake (n = 8) or limit fed by 50% for 5 d (n = 8). In both cases increased ($P < 0.05$) PC mRNA was specifically due to increased ($P < 0.05$) expression of PC 5'UTR variants A, B, C, and F, the products of promoter 1. Rat hepatoma cells transiently transfected with bovine PC promoter-luciferase constructs containing promoter 1 and exposed to serum from feed restricted cows had greater ($P < 0.05$) PC promoter 1 activity compared with cells exposed to control serum. Abundance of PC mRNA was increased ($P < 0.05$) in Madin-Darby Bovine Kidney (MDBK) cells exposed to fatty acid combinations that mimicked NEFA profiles at calving. Thermal stress (42°C for 24 h) induced ($P < 0.05$) endogenous PC mRNA expression in bovine hepatocytes and MDBK cells but this effect was mainly due to an increase in the activity of PC promoter 3. Together, these data indicate that changes in PC mRNA expression at calving and during feed restriction that are due to increased promoter 1 activity and primarily due to the action of fatty acids to activate PC promoter 1. Conversely, heat stress, a condition that does not increase NEFA, elevates PC mRNA expression through activation of promoter 3 through a mechanism which has not yet been elucidated. Collectively these data indicate differential regulation of the PC gene promoters in response to metabolic and environmental cues as part of the role of PC in coordinating whole body energy metabolism.

Key Words: pyruvate carboxylase, transition to lactation, feed restriction, heat stress

282 Efficacy of using gender selected semen in fixed-time AI protocols in dairy heifers. D. A. Mallory*¹, S. L. Lock², D. C. Woods², S. E. Poock¹, and D. J. Patterson¹, ¹University of Missouri, Columbia, ²Genex Cooperative, Inc, Shawano, WI.

This experiment was conducted to compare pregnancy rates resulting from fixed-time AI (FTAI) after administration of the Show-Me-Synch protocol with conventional (CON) or gender selected (GS) semen. Semen was collected from a single Holstein sire. Holstein heifers (n = 240) were assigned to treatment by BW, and reproductive tract score.

All heifers received an Eazi-Breed controlled internal drug release (CIDR) insert from d 0 to 14 followed by PGF_{2α} (PG; 25 mg intramuscularly) 16 d later (d 30). Artificial insemination was performed by a professional technician at 66 h after PG for heifers in both treatments and all heifers were administered GnRH (100 μg intramuscularly) at the time of AI. Heifers were fitted with Estroject heat detector patches at PG to characterize estrous response before FTAI. Estrous response did not differ ($P = 0.2$) between CON (63/120; 53%) and GS (70/120; 58%) treatments. However, CON treated heifers achieved significantly higher ($P < 0.01$) fixed-time AI pregnancy rates (82/120; 68%) compared with GS (45/120; 38%) treated heifers. Overall heifers that exhibited estrus (76/133; 57%) tended ($P = 0.06$) to have higher pregnancy rates resulting from FTAI than heifers that failed to exhibit estrus (51/107; 48%). Pregnancy rates resulting from fixed-time AI did not differ ($P = 0.4$) for CON heifers that exhibited estrus (44/63; 70%) compared with CON heifers that failed to exhibit estrus (38/57; 67%). Heifers in the GS treatment that exhibited estrus (32/70; 46%) had significantly higher ($P < 0.05$) pregnancy rates resulting from FTAI compared with heifers that failed to exhibit estrus (13/50; 26%). In summary, pregnancy rates resulting from FTAI were higher for heifers that were inseminated with conventional semen compared with those that received gender selected semen. Further studies are required to develop strategies for using gender selected semen when inseminating heifers at predetermined fixed times on the basis of expression of estrus before AI.

Key Words: controlled internal drug release insert, dairy heifer, fixed-time artificial insemination, gender selected semen

283 Transcript abundance of hormone receptors, glucose transporters, mTOR pathway related kinases and ligand, and milk protein-encoding genes in mammary tissue of peri-parturient, lactating and post-weaned sows. R. Manjarin,* J. P. Steibel, R. N. Kirkwood, N. P. Taylor, and N. L. Trottier, *Michigan State University, East Lansing.*

The objective of these experiments was to test the hypothesis that transcript abundance of hormone receptors, glucose transporters, mTOR pathway related kinases and ligand, and milk protein-encoding genes increase in the porcine mammary gland in response to higher lactation demand. Genes included those encoding for the receptors of growth hormone (GHR), insulin (INSR), glucocorticoid (GCR) and prolactin (PRLR), glucose transporters GLUT1 (SLC2A1) and GLUT4 (SLC2A4), insulin growth factor 1 (IGF-1), mTOR (FRAP1) and p70S6 kinases (RPS6KB1), and milk proteins α-lactalbumin (LALBA) and β-casein (CSN2). Mammary tissue was biopsied from 4 sows on d 110 of gestation (pre-partum), d 5 (early) and 17 (peak) of lactation, and d 5 after weaning (post-weaning), and gene expression quantified by real-time PCR (qPCR). Compared with pre-partum, early lactation increased ($P < 0.001$) GCR, GLUT1, CSN2 and LALBA

and decreased ($P < 0.001$) PRLR mRNA abundance. Compared with early lactation, peak lactation tended to increase ($P > 0.07$) GCR and SLC2A1, increased PRLR ($P < 0.001$) and LALBA ($P < 0.05$), tended to decrease RPS6KB1 ($P = 0.06$), and decreased GHR ($P < 0.001$) and IGF-1 ($P < 0.01$). Expression of INR and FRAP1 did not differ when comparing either pre-partum or peak lactation to early lactation. Compared with peak of lactation, post-weaning decreased ($P < 0.01$) GCR, PRLR, SLC2A1, CSN2 and LALBA, did not affect INSR and GHR, and increased IGF-1 ($P < 0.05$) and SLC2A4 ($P < 0.001$) mRNA abundance. Across stages of mammary physiological activity, mRNA abundance of GCR was positively correlated with that of CSN2 ($r = 0.85$ and $P < 0.001$) and LALBA ($r = 0.79$ and $P < 0.01$), whereas mRNA abundance of GHR was correlated with that of IGF-1 ($r = 0.7$ and $P < 0.01$) and RPS6KB1 ($r = 0.54$ and $P < 0.05$). In conclusion, GHR, PRLR, GHR, SLC2A1, IGF-1, RPS6KB1, CSN2 and LALBA changed in porcine mammary gland over pre-partum to peak lactation period, and therefore may be involved in regulation of milk synthesis in response to higher lactation demand.

Key Words: lactation, receptor, mTOR, sow

284 The ontogeny of intestinal carbohydrate digestive, absorptive and nutrient sensing proteins in pigs. M. Al-Rammahi^{*1}, A. Moran¹, D. Batchelor¹, P. Sangild², C. Ionescu³, D. Bravo³, and S. Shirazy-Beechey¹, ¹University of Liverpool, Liverpool, United Kingdom, ²University of Copenhagen, Frederiksberg, Denmark, ³Pancosma, Geneva, Switzerland.

In the small intestine, dietary carbohydrate is hydrolysed ultimately by intestinal brush border membrane hydrolases, sucrase, lactase and maltase, to glucose, galactose and fructose. Glucose and galactose are transported across the luminal membrane of enterocytes by the Na⁺/glucose cotransporter 1, SGLT1, which is upregulated by luminal sugars via the sweet taste receptor, T1R2/T1R3, expressed in enteroendocrine cells. Na⁺-independent transporters, facilitate transport of fructose across the luminal membrane (GLUT5) and all 3 monosaccharides across the basolateral membrane (GLUT2). Aim: To determine the developmental profile of these key carbohydrate digestive-related gut functions in pigs before and after birth. Methods: Intestinal tissues were removed from pre-term (fetal age 105 d, n = 4), full-term (115 d, n = 4), suckling (15 d, n = 4) and weaned (28 d, n = 8) piglets following euthanasia under ethical approval. Results: By immunohistochemistry, we showed presence of SGLT1 (on enterocytes luminal membrane), GLUT2 (on enterocytes basolateral membrane) and the glucose sensor (in enteroendocrine cells) both before and after birth; GLUT5 protein was only present after weaning. By functional assays and qPCR, we demonstrated highest expression of SGLT1 in weaned animals (on 60% carbohydrate diet). The expression level of SGLT1 was weaned > suckling > term > pre-term. A similar pattern of expression was observed for sucrase and maltase, while the developmental profile of lactase expression showed maximal levels in suckling animals. The presence of carbohydrate digestive/absorptive and nutrient sensing proteins in the intestine during pre-natal life indicates that a pre-programming of intestinal functions occurs before birth to prepare the gut for its post-natal functional demands. A better understanding of both 'hard wired' and diet-induced functions of the gut in early life allows the design of rational and innovative approaches to formulate feed and feed additives to ensure the health and well-being of the young animal.

Key Words: gut development, sugar transporters, disaccharidases, weaning piglet

285 Maintenance energy requirements of gestating beef cows and plasma concentration of thyroxine and triiodothyronine. T. A. Pye,* B. H. Boehmer, and R. P. Wettemann, Oklahoma Agricultural Experiment Station, Stillwater, OK.

Spring calving, Angus cows (n = 40), were used to determine the effects of maintenance energy requirement (MR) on plasma concentrations of thyroxine (T4) and triiodothyronine (T3). Cows (4 to 7 yr of age) with an initial BCS 4.9 ± 0.1 and BW of 553 ± 5.9 were individually fed a complete ration for 10 wk (rep 1) during 4–8 mo of gestation. After 2 wk on a ration calculated to supply MR (Model 1, NRC 1996) cows were weighed twice weekly and intake of the ration was adjusted weekly until constant BW was achieved (regression analysis). Body weight was maintained for 21 d for 27 cows and the amount of feed consumed was designated as actual MR. Blood samples were collected before (fasted) and after consumption of feed on 2 d in January when cows consumed MR, and on 2 d in May before and after ad libitum consumption of roughage. Cows were classified based on MR as low (>0.5 SD less than mean, LMR), mod (± 0.5 SD of the mean, MMR) and high (>0.5 SD greater than mean, HMR). Average MR was 80.75 (SD = 4.84) Kcal \cdot kg^{-0.75} \cdot day⁻¹ and the difference in MR between the least efficient and most efficient cow was 33%. In a previous replication with similar methods [J. Anim. Sci.(E-Suppl. 2)88:403], there was a treatment x day effect on plasma concentration of T3 ($P = 0.01$) and T4 ($P = 0.02$) when max ambient temperature was -4°C or 15°C on the 2 d blood samples were collected. When the maximum ambient temperature was 15°C , HMR had greater plasma concentration of T3 compared with LMR cows. In the current experiment when maximum ambient temperature was 2°C or 13°C on the January sampling days and 26°C or 28°C on the May sampling days, plasma concentrations of T3 and T4 were not influenced ($P > 0.11$) by MR of cows. Concentrations of thyroid hormones in plasma are not influenced by MR of beef cows during late gestation. Identification of cows with lower MR could improve profitability of beef production.

Key Words: beef cows, maintenance, triiodothyronine

286 Fasting induced adipocyte factor increases with reduced energy balance in lactating Holstein cows. D. A. Koltes* and D. M. Spurlock, Iowa State University, Ames.

Appropriate regulation of lipids toward utilization or storage is essential to the long-term productivity of dairy cows. Fasting induced adipocyte factor (FIAP) is an adipokine that decreases lipid storage in adipose tissue by inhibiting lipoprotein lipase activity. Therefore, FIAP may be important to the regulation of energy partitioning during lactation. We measured FIAP mRNA abundance in adipose tissue of Holstein cows following feed restriction, growth hormone administration, and throughout the transition period to determine if FIAP mRNA abundance changes in these models of altered energy balance. Adipose tissue was collected from mid lactation cows (175–210 DIM) 6d before and 1 and 4d after the initiation of feed restriction, and 4d before and 3 and 7d after administration of growth hormone. Adipose tissue was also collected during the transition period, approximately 21d before calving, 5–9 DIM (5 DIM), 21–31 DIM (21 DIM), and 150–161 DIM (150 DIM). Daily feed intake and milk production were recorded for calculation of net energy balance. As expected, net energy balance decreased ($P < 0.05$) and serum non-esterified fatty acids increased ($P < 0.05$) with feed restriction, growth hormone administration, and the onset of lactation. FIAP mRNA abundance increased with declining energy balance in all 3 models ($P < 0.01$), with changes of 4, 3, and 6.5 fold in GH, feed restricted, and transition cows, respectively. These

results demonstrate that mRNA abundance of FIAF in adipose tissue is significantly regulated in lactating cows. Given the known function of FIAF as a potent inhibitor of lipoprotein lipase, these data are consistent with the hypothesis that FIAF participates in coordinated changes to minimize lipid storage and facilitate their utilization as an energy substrate or for milk synthesis.

Key Words: feed restriction, transition period, growth hormone, gene expression

287 Adipose triglyceride lipase protein abundance decreases following growth hormone administration and feed restriction in lactating Holstein cows. M. P. Faylon* and D. M. Spurlock, *Iowa State University, Ames.*

During early lactation, the dairy cow experiences negative energy balance (NEB), due in part to reduced dry matter intake coupled with increased energy requirements for milk synthesis. To adapt to this condition, cows mobilize body energy reserves from adipose tissue. Adipose triglyceride lipase (ATGL) has been identified as an initiator of triacylglyceride hydrolysis from lipid droplets, and thus plays an integral role in lipolysis. In this study, the protein abundance of ATGL in 2 different models was investigated. Thirty-eight Holstein cows in mid-lactation (175–210 DIM) were randomly chosen and allocated to 2 groups to evaluate the effects of growth hormone (GH) administration ($n = 18$) and feed restriction ($n = 20$) on protein abundance of ATGL. For GH administration, adipose tissue and blood samples were collected 4d before, and 3 and 7d post administration of GH. Similarly, adipose and blood samples were obtained 6d before, and 1 and 4d after initiation of feed restriction. Daily feed intake and milk production were recorded for calculation of energy balance. Energy balance significantly decreased ($P < 0.05$) and serum non-esterified fatty acids significantly increased ($P < 0.05$) following both GH administration and feed restriction. There was a significant decrease in ATGL protein following GH administration ($P < 0.001$). Additionally, ATGL protein decreased with feed restriction ($P < 0.001$), although this response was variable across cows. The significant decrease in ATGL protein during times of increased lipolysis was unexpected, given the known role of ATGL as an initiator of lipolysis. These results demonstrate that ATGL protein abundance is regulated in response to changes in energy status in lactating cows. However, the relationship between ATGL protein abundance and activity, and the mechanism of its regulation remain to be defined.

Key Words: bovine somatotropin, feed restriction, energy balance, adipose triglyceride lipase

288 Effect of ambient temperature on ruminal temperature in beef cows. B. H. Boehmer,* T. A. Pye, and R. P. Wettemann, *Oklahoma Agricultural Experiment Station, Stillwater, OK.*

Ruminal temperature (RuT) is a measure of core body temperature and can be used to identify physiological events in beef cows. Exposure of cows to elevated ambient temperature may influence usefulness of RuT to predict estrus, parturition, or health. The effect of elevated ambient temperature on RuT has not been established. The objective of this study was to evaluate the effect of ambient temperature on RuT in beef cows. Angus cows ($n = 12$) were administered temperature boluses (SmartStock, LLC) with a balling gun. Temperature boluses were programmed to transmit RuT every hour. Ruminal temperature was collected on 8 d during the summer (June and August) and winter

(January). Ambient temperature was collected hourly (www.mesonet.org) and ranged from 2 to 20°C in January and 11 to 37°C in June and August. Data were analyzed with GLM and CORR (SAS Inst. Inc., Cary, NC). Mean RuT for all cows was $38.23 \pm 0.02^\circ\text{C}$. Ruminal temperature was increased ($P < 0.05$) when ambient temperature was greater than 32°C. Ruminal temperature was correlated with ambient temperature ($r = 0.18$, $P < 0.01$) and cattle temperature humidity index ($r = 0.17$, $P < 0.01$). Respiration rate (RR), rectal temperature (RT), and RuT were evaluated on 2 consecutive days when maximal ambient temperature was 37 (HOT) or 27 ° (WARM). Ruminal temperature, RR and RT were greater ($P < 0.05$; $40.2 \pm 0.1^\circ\text{C}$, 114 ± 3 , $40.8 \pm 0.1^\circ\text{C}$, respectively) on the HOT day compared with the WARM day ($37.5 \pm 0.1^\circ\text{C}$, 36 ± 3 , $38.1 \pm 0.1^\circ\text{C}$). Ruminal temperature was correlated ($P < 0.001$) with RR ($r = 0.95$) and RT ($r = 0.97$). Use of RuT for prediction of physiological events may be influenced by elevated ambient temperature.

Key Words: ruminal temperature, ambient temperature, beef cows

289 Mitigation of effects of heat stress in mice by Artemisia sp. C. C. Selby*¹, K. S. Roberts¹, T. M. Taxis¹, D. Fisher², and W. R. Lamberson¹, ¹University of Missouri, Columbia, ²University of Western Cape, Cape Town, South Africa.

Heat stress results in economic losses to livestock producers and is of critical importance in human health. *Artemisia afra* (AAF) is a herb used by indigenous peoples of South Africa to alleviate heat stress during desert travel and *Artemisia absinthium* (AAB) is a related plant grown in the US Mice given a decoction of AAF before exposure to high temperatures had greater fluid consumption and activity during acute heat stress than mice given tap water, but core body temperature did not differ between the groups. Our hypothesis in the present experiment was that AAF and AAB reduce metabolic rate and heat production allowing heat-stressed animals to tolerate high temperatures. The aims of this experiment were to determine if effect of treatment with these herbs allows maintenance of normal activity and decreases metabolic rate over a 5-d period of mice exposed to heat. Male mice (ICR strain, $n = 50$) were housed in individual cages at 21°C. Tail temperatures were recorded for 5 d, mice were then given ad libitum access to a 1% w/v decoction of AAF, AAB or tap water (TW) for 5 d before 5 d exposure to a 35°C environment. Each mouse had access to an activity wheel which recorded the distance traveled and total time spent running in each 24 h period. Metabolic rate was calculated based on measurements of O₂ consumption, CO₂ production and respiratory exchange ratio collected in individual indirect calorimeters. Feed consumption, fluid intake, tail temperature, metabolic rate, and running time and distance were fitted to a repeated measures mixed model which included the effects of treatment, day, thermal environment and mouse. Daily running distance ($P < 0.001$) and metabolic rate ($P = 0.01$) were higher in AAB than other treatments during heat stress. Both AAF and AAB had increased ($P = 0.03$) fluid consumption before the heat stress, but during heat stress no difference was found. Both AAF and AAB had a lower ($P < 0.001$) tail temperature than TW during the heat stress period. Pretreatment with AAB may alleviate effects of heat stress.

Key Words: mice, artemisia, heat stress, metabolic rate

290 Effects of heat stress and nutrition on pig physiology and performance. S. C. Pearce,* N. C. Upah, N. K. Gabler, and L. H. Baumgard, *Iowa State University, Ames.*

Heat stress (HS) negatively affects pig performance variables and is thus a costly industry issue. It is unknown whether or not HS is directly or indirectly (via reduced feed intake) responsible for the suboptimal production. Crossbred gilts ($n = 48$; 35 ± 4 kg BW) were housed in constant climate controlled rooms in individual pens and exposed to 1) thermal neutral (TN) conditions (20°C ; 35–50% humidity) with ad libitum intake ($n = 18$), 2) HS conditions (38°C ; 20–35% humidity) with ad libitum intake ($n = 24$) or 3) pair-fed (PF in TN conditions [PFTN], $n = 6$: to eliminate confounding effects of dissimilar feed intake [FI]) and sacrificed at 1, 3, or 7d of environmental exposure. Individual rectal temperature (T_r), skin temperature (T_s), respiration rates (RR) and FI were determined daily. Pigs exposed to HS had an increase ($P < 0.01$) in T_r (39.3 vs. 40.8°C) and a doubling in RR (54 vs. 107 bpm). HS pigs had an immediate (d1) decrease (47% ; $P < 0.05$) in FI which continued through d7; by design the PFTN controls nutrient intake pattern mirrored the HS group. TN pigs had 1.14 kg BW ADG throughout the experiment, while HS pigs lost 2.7 kg BW after 1d and had 0.24

kg of BW ADG by d7. At d7, PFTN pigs had a -0.35 kg BW ADG. Both HS and PFTN pigs had reduced (8.9% ; $P < 0.05$) plasma glucose compared with TN pigs. BUN concentrations were elevated (36% ; $P < 0.05$) in HS pigs after 24h but returned to TN control levels by d3. Plasma cholesterol increased ($P < 0.05$) in HS pigs at 24h (25%) and d3 (22%) but were similar to TN and PFTN pigs by d7. HS pigs had an immediate and sustained increase (50% ; $P < 0.05$) in plasma creatinine compared with both TN and PFTN controls. Plasma alkaline phosphatase (ALK) was progressively decreased ($P < 0.05$) during HS, and was 50% lower in HS compared with TN and PFTN pigs on d7. There were little or no treatment differences in plasma triglycerides, total protein, creatine kinase, or gamma-glutamyltranspeptidase (GGT). These data indicate HS pigs gained more BW (composition unknown) than PFTN controls, and demonstrate that additional factors besides reduced feed intake contribute to poor performance during HS.

Key Words: heat stress, pig

Tuesday, March 15, 2011

SYMPOSIA AND ORAL SESSIONS

Ruminant Nutrition: Excess Dietary Nitrogen—Effects on Metabolism, Productivity, the Environment and Future Regulations Symposium

291 (Invited) Future direction of water and air regulations for livestock facilities. D. Porter,* *Environmental Protection Agency, Kansas City, KS.*

In 1972 Congress enacted the Clean Water Act which defined Concentrated Animal Feeding Operations or CAFOs as point sources. In 1974 and 1976, the EPA established the first effluent limitation guidelines and National Pollution Discharge Elimination System or NPDES permit regulations for livestock facilities defined as CAFOs. In 2003, EPA revised the regulations to require nutrient management plans and require all CAFOs that discharge or have the potential to discharge obtain a permit. EPA was sued by industry and environmental groups. In 2005, the 2nd Circuit Court of Appeals Decision vacated the 2003 rule requirement that all CAFOs had a duty to apply and required that all NPDES permits and NMPs must be available for public review and comment before issuance. In 2008, EPA published the revised CAFO Rules. EPA was again sued by both industry and environmental groups. In 2010, EPA settled with the environmental groups and agreed to issue guidance for assessing whether a AFO, discharges or proposes to discharge and to propose a rule regarding collection of information from all CAFOs. The duty to apply guidance has been issued and EPA is currently working on the 308 Rule and will be seeking public comment in the near future. The 2008 Rule required all CAFOs that discharge or propose to discharge to obtain an NPDES permit. Recently, select industry groups have argued to the 5th Circuit Court that the Clean Water Act defines only CAFOs that discharge as point sources, not those that propose to discharge. As part of the Chesapeake Bay settlement, EPA is currently examining the need for changes to the CAFO designation rule that would enable EPA to designate a medium-sized feedlot as a point source. Livestock facilities located along impaired watersheds that discharge to surface waters will be a focus in the future. EPA is currently reviewing both its policy and scientific assessment of the particulate matter ambient air standards, but no decisions have been made. Currently, only the largest CAFOs are required to report hazardous air emissions under the Emergency Planning and Community Right to Know Act.

Key Words: regulation

292 (Invited) The environmental impact of improving productivity in US beef production systems. J. L. Capper,* *Washington State University, Pullman.*

Extensive livestock production systems are commonly perceived to be inherently more environmentally sustainable than conventional beef production systems. A deterministic model was used to compare the environmental impact of the 1977 and 2007 US beef industries. The model integrated resource inputs and waste outputs from animal nutrition and metabolism, herd population dynamics and cropping parameters using a modified life cycle assessment approach. System

boundaries extended from the cow-calf operation to arrival at the slaughter plant. The beef population required to produce one unit of beef in 2007 was reduced by 30% compared with 1977. This difference was conferred both by improved productivity and by dairy calves entering the beef production chain, thus reducing the number of support animals required. Between 1977 and 2007, total land area and water use per unit of beef were reduced by 34% and 13% respectively. Comparative methane and nitrous oxide emissions per unit of beef produced were reduced by 20% and 11% respectively. The carbon footprint was therefore reduced by 18% in 2007 compared with 1977. The same model was used to analyze the environmental impact of corn-fed beef finishing systems with or without technology (conventional vs. natural), compared with grass-fed systems. Improved productivity in the conventional system resulted in 2.6 total animals (growing animals plus supporting population) being required to produce 363 kg of beef, compared with 3.0 and 4.5 animals in the natural and grass-fed systems. Land area per 363 kg beef was increased from 1.95 ha in the conventional system to 2.40 ha in the natural system and 3.58 ha in the grass-fed system. Conventional beef production used the equivalent of 0.44 US households supply of water per carcass (166,676 L), while the natural and grass-fed systems used the equivalents of 0.51 and 1.85 US households' water supply. The carbon footprint of the conventional system was 5,596 kg CO₂-equivalents per 363 kg beef, equivalent to annual emissions from 1.11 average US cars, compared with 1.30 cars (natural system) and 1.92 cars (grass-fed system). These analyses clearly demonstrate that advances in US beef industry productivity considerably reduce the environmental impact of modern beef production.

Key Words: beef, productivity, environmental Impact, carbon footprint

293 (Invited) Nutrition - An effective tool for mitigating ammonia emissions from dairy and feedlot operations. A. N. Hristov*¹, M. Hanigan², A. Cole³, R. Todd³, T. A. McAllister⁴, P. M. Ndegwa⁵, and A. Rotz⁶, ¹*Pennsylvania State University, University Park,* ²*Virginia Polytechnic Institute and State University, Blacksburg,* ³*USDA-ARS, Bushland, TX,* ⁴*Lethbridge Research Centre, Lethbridge, Canada,* ⁵*Washington State University, Pullman,* ⁶*USDA-ARS, University Park, PA.*

Ammonia emitted from animal feeding operations is a potential environmental and human health hazard, contributing to eutrophication of surface waters and nitrate contamination of ground waters, soil acidity, and fine particulate matter formation. It may also contribute to global warming through nitrous oxide formation. Thus, reducing ammonia emissions from dairy and beef cattle operations is critical to achieving environmentally sustainable animal production that will benefit producers and society at large. Ammonia emission factors and flux rates from animal operations are extremely variable. For example, dairy farms emission factors from 0.82 to 250 g ammonia per cow

per day have been reported, with an average of 59 g per cow per day (n = 31). Ammonia flux rates for dairy farms averaged 1.03 g per m² per hour (n = 24). In contrast, ammonia losses are greater from beef feedlots, where emission factors average 119 g per animal per day (n = 9) with values as high as 280 g per animal per day. Ammonia flux rate for beef feedlots averaged 0.174 g per m² per hour (n = 12). Using N mass balance approaches, daily ammonia N losses of 25 to 60% of the N excreted in manure have been estimated for dairy cows and feedlot cattle. Practices to mitigate ammonia emissions include reducing excreted N (particularly urinary N), acidifying ammonia sources, or binding ammonium to a substrate. Reducing crude protein concentration in cattle diets and ruminal protein degradability are powerful tools for reducing N excretion, the ammonia-emitting potential of manure, and whole-farm ammonia emissions. Decreasing dietary crude protein concentration may reduce the ammonia emitting potential of manure by as much as 40 to 50%. Reducing dietary crude protein can also benefit the producer by reducing feed cost. These interventions, however, have to be balanced with the risk of lost production.

Key Words: ammonia emission, manure, dairy cow, beef cattle

294 (Invited) Diet impacts on manure nitrogen concentration and acreage requirements. G. E. Erickson,* T. J. Klopfenstein, V. R. Bremer, and A. K. Watson, *University of Nebraska, Lincoln*.

The impact of dietary nitrogen on manure nitrogen is dependent on animal housing and subsequent manure handling methods. In open, beef feedlots, diet and other factors impact manure N concentration. While a direct relationship exists between dietary N and N excretion, the relationship between dietary N and manure is poor due to N volatilization losses in open lot systems. Feeding less protein did not impact manure N ($P > 0.35$) in a series of 6 experiments where cattle were phase-fed to minimize excess protein relative to requirements compared with industry average dietary protein. In confined housing systems where manure is collected and surface area exposure of manure minimized, dietary N is more directly related to manure N. Other dietary factors can increase manure N in open lot systems (and decrease N losses) such as changing the route of excretion from feces to urine, increasing OM in manure by decreasing diet digestibility, acidifying manure through diet manipulation, and use of some feed additives. Most beef finishing diets contain ethanol byproduct feeds that increase dietary protein well above requirements. When wet distillers grains plus solubles (WDGS) were fed at 0% compared with 30%, manure N was numerically increased by 2 kg ($P = 0.27$) in one experiment and increased by 4.5 kg ($P = 0.07$). However, N excretion increased by 12.8 and 13.7 kg/steer over the feeding period in those 2 experiments when 30% WDGS were fed compared with none. A model was developed called FNMP economics for both beef and dairy operations to accurately predict nutrient excretion, manure nutrients,

land application area needed, and economics of distributing manure with different dietary scenarios. The distribution costs increase when manure N increases if manure is spread on a N basis. However, costs do not increase when manure is spread on a P basis due to a low N:P ratio. Additionally, the value of manure likely offsets the costs of distributing manure, but is dependent on value assigned to manure N, availability of manure N, and whether additional land area is available.

Key Words: cattle, land application, manure, nitrogen

295 (Invited) Mitigation strategies to reduce ammonia and methane emission from dairy farms. M. J. Aguerre*¹, M. A. Wattiaux¹, J. M. Powell², and C. Arndt¹, ¹*University of Wisconsin, Department of Dairy Science, Madison*, ²*U.S. Dairy Forage Research Center, Madison, WI*.

Experiments were conducted to evaluate possible mitigation strategies to reduce ammonia (NH₃) and methane (CH₄) emission from dairy farms. Results indicated that by maintaining a consistently lower dietary CP (18.2 vs. 16.7% DM) it was possible to achieve on average a 27% reduction in NH₃ emission from a free-stall barn managed under farm-like condition. Feeding tannins at a level that does not compromise animal performance might be used to reduce urinary N and therefore NH₃ emissions. Data from a lactation study suggested that incorporating tannin in the diet at 1.8% DM at 2 dietary CP levels (15.5 vs. 16.8% DM), did not alter manure N but increased fecal N and reduced urine N, with limited impact on animal performance. Manure from cows fed 1.8% tannin and 15.5 or 16.8% dietary CP, emitted 30.5 and 16.3% less NH₃ than no tannin diet, respectively. Management practices to achieve further NH₃ emission reduction beyond manure collection were also evaluated. Reducing initial manure N by 27% consistently reduced average NH₃ emission rate by 36% during 136 d of storage. The addition and mixing of straw into stored manure reduced overall NH₃ emission by 28%, regardless of initial manure N content. Two trials in air-flow controlled chambers were conducted to measure possible trade-offs in NH₃ and CH₄ emissions. In trial 1, increasing the proportion of forage in the diet from 47 to 68% while maintaining dietary CP, increased CH₄ emission per unit of milk by 25% but did not alter NH₃ emission or milk production. In trial 2, alfalfa silage (AS) and corn silage (CS) were fed at 20:80, 40:60, 60:40 and 80:20 ratio, in a 55:45 F:C ratio diet. Varying the AS:CS ratio had no effect on NH₃ emission. Although greatest CH₄ emission was observed at 40:60 ratio, primary forage did not affect CH₄ emission per unit of milk. Future research should assess the additive effect of combining different mitigation strategies and the potential trade-offs between NH₃ and CH₄ emission reductions.

Key Words: ammonia, methane, dairy

Ruminant Nutrition: By-Product Utilization (Distillers Grains)

296 Use of dry rolled corn, dry or wet distillers grains plus solubles as an energy source in high forage diets for growing cattle.

N. A. Ahern,* B. L. Nuttelman, T. J. Klopfenstein, and G. E. Erickson, *University of Nebraska, Lincoln*.

Crossbred steers (n = 120 2 blocks; initial BW = 247 ± 10 kg and 317 ± 28 kg) were used in a RCBD to determine the energy value of distillers grains relative to corn in high forage diets. The growing trial was conducted over 84 d, with steers fed individually utilizing the Calan gate system. Energy sources were fed at a low or high inclusion for 3 energy sources: dry distillers grains plus solubles (DDGS, 15 or 30% of diet DM) wet distillers grains plus solubles (WDGS, 15 or 30% of diet DM), or dry rolled corn (DRC, 22 or 50% of diet DM), with a 60:40 blend of grass hay and sorghum silage, and supplement. Diets were formulated using the NRC (1996) model to meet or exceed metabolizable protein (MP) requirements. Within inclusion level, diets were calculated to contain the same amount of energy assuming DGS contains 108% TDN. Gain was predicted at 0.79 kg/d for the low inclusion level at 15% and 1.08 kg/d for the high inclusion level at 30% DGS. Dry rolled corn diets were formulated for equal ADG which calculated to 22% and 50% corn for low and high inclusion, respectively. By design, DMI and ADG were similar among treatments ($P = 0.42$ and 0.78). Gain to feed was not different among treatments ($P = 0.61$). Using the NRC (1996) model, energy content of the feed can be predicted from ADG and DMI. The NRC energy adjusters were used to predict actual ADG on the DRC diet with the TDN of corn set at 83%. The TDN value of WDGS and DDGS was calculated to be 98.5% and 94.5%, respectively. Therefore the energy value of WDGS and DDGS was estimated to be 120% and 114%, respectively, the value of corn. This trial reiterates that WDGS and DDGS have a high energy value relative to corn in forage based diets, which is likely due to energy density of fat, undegradable intake protein, low starch level, and highly digestible corn fiber.

Key Words: beef cattle, energy value, distillers grains

297 Strategies of supplementing dried distillers grains to yearling steers grazing smooth bromegrass pastures.

S. K. Pruitt,* K. M. Rolfe, B. L. Nuttelman, A. K. Watson, W. A. Griffin, T. J. Klopfenstein, G. E. Erickson, and W. H. Schacht, *University of Nebraska, Lincoln*.

Dried distillers grains plus solubles (DDGS) supplementation of cattle grazing smooth bromegrass over the growing season has suggested that supplementation strategies may be beneficial to performance. The effects of supplementation strategies of DDGS daily on cattle performance were evaluated using 75 yearling steers (294 ± 7 kg) grazing smooth bromegrass pastures. Treatments included: paddocks fertilized (FERT) at 90 kg N/ha, non-fertilized paddocks supplemented (SUPP) at 0.6% of BW with DDGS daily (1.76–2.62 kg/hd/d) and control paddocks (CON) with no fertilizer or supplementation. Incremental supplementation treatment (STRAT) on a non-fertilized paddock with increasing levels of DDGS supplemented daily through cycles 1 to 5 (0.90, 1.59, 2.27, 2.95, and 3.18 kg/hd/d, respectively) corresponded with changes in grass quality over growing season. Paddock was the experimental unit with FERT, SUPP and CON treatments replicated 4 times and STRAT treatment replicated 3 times. Paddocks CON were stocked at 6.8 AUM/ha and FERT, SUPP and STRAT at 9.9 AUM/ha. Treatment paddocks were divided into 6 strips for cattle to be managed on a rotational system over 5 cycles. Durations of cycles 1 and 5

were 24 d and cycles 2 to 4 were 36 d. Grazing pressure among treatments was maintained with the use of put-and-take cattle. Final BW differed ($P < 0.01$) among treatments. Treatment affected ADG ($P < 0.01$) with CON and FERT gaining the least, but not different (0.91 and 0.84 kg/d, respectively; $P = 0.15$). Average daily gain was greater for steers on SUPP (1.18 kg/d), which was different than ADG of STRAT steers (1.07 kg/d, $P < 0.05$). Steers on STRAT gained more than CON and FERT (0.16 and 0.23 kg/d, respectively; $P < 0.01$). Supplementation improved ADG over fertilized and non-supplemented treatments. Incrementally increasing DDGS supplementation over the growing season for grazing yearlings did not increase ADG.

Key Words: dried distillers grains, grazing, supplementation

298 Effects of feeding increasing levels of corn condensed distillers solubles on performance of feedlot cattle.

A. C. Pesta,* B. L. Nuttelman, G. E. Erickson, T. J. Klopfenstein, and W. A. Griffin, *University of Nebraska, Lincoln*.

Two hundred 50 steers (BW = 355 ± 18 kg) were utilized in a RCBD to evaluate the effects of feeding increasing levels of corn condensed distillers solubles (CDS) on performance and carcass characteristics. Dietary treatments consisted of: 0, 9, 18, 27, or 36% CDS, replacing a portion of both urea and a 1:1 ratio of dry-rolled corn and high-moisture corn. Urea was included at 1.58% in the control diet to provide 13.6% CP, and decreased to 0.35% in 36% CDS diet with 14.7% CP. All diets contained 7.5% alfalfa hay and 5% dry supplement. Dietary fat increased from 3.7 to 9.4%, whereas dietary sulfur increased from 0.12 to 0.48%, comparing 0 to 36% CDS. 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 132 d. Intake decreased linearly ($P < 0.01$) as CDS inclusion increased. A quadratic response was observed for ADG ($P = 0.01$), with maximum gain calculated at 20.8% CDS, with all inclusions increased versus 0% CDS. A quadratic improvement in G:F was observed ($P < 0.01$), with a calculated maximum at 32.5% CDS, at which steers were 12% more efficient than those fed 0% CDS. A quadratic response ($P = 0.01$) was also observed for HCW as CDS inclusion increased, with steers fed 18% CDS having 15 kg heavier HCW than control groups, and, all CDS levels were heavier than 0% CDS. No differences were observed for LM area, fat thickness, or marbling scores among treatments. Relative feeding value was calculated for each CDS inclusion versus 0% CDS by dividing the difference in G:F by the G:F of 0% CDS, then by percent inclusion of CDS. Relative feeding values were 210, 166, 142, and 139% of corn for 9, 18, 27, and 36% CDS, respectively. Feeding up to 36% CDS may effectively reduce dietary inclusion of corn, while improving gain and G:F in finishing diets, with maximal performance between 20.8 and 32.5% inclusion (DM basis).

Key Words: distillers solubles, fat, feedlot

299 Effects of different ratios of steam-flaked corn and dry-rolled corn on finishing performance and carcass traits of feedlot cattle fed distillers grains with solubles.

C. A. Nichols*¹, K. H. Jenkins², G. E. Erickson¹, S. A. Furman², and T. J. Klopfenstein¹, ¹University of Nebraska, Lincoln, ²University of Nebraska Panhandle Research and Extension Center, Scottsbluff.

A finishing trial was conducted to evaluate the effects of feeding different ratios of dry-rolled corn (DRC) and steam-flaked corn (SFC) in diets that contain 0 or 35% wet distillers grains plus solubles (WDGS, DM basis) on performance and carcass characteristics. This study utilized 480 crossbred yearling steers (354 ± 23 kg) in a RCBD with a 2×5 factorial treatment structure. One factor was ratios of SFC:DRC which were 0:100, 25:75, 50:50, 75:25, or 100:0 of the grain mix. The other factor were diets included either 0% WDGS with 81.5% corn (ratios of SFC:DRC) or 35% WDGS with 48.5% corn (ratios of SFC:DRC; DM basis). All diets contained 7% corn silage, 3.5% alfalfa, and 8% liquid supplement. A WDGS \times corn processing ratio interaction ($P = 0.03$) was observed for G:F. Cattle fed diets containing no WDGS with SFC as the sole source of corn had 11% greater G:F ($P < 0.01$; 0.189) compared with steers fed all DRC diets with no WDGS (0.170). As SFC replaced DRC in diets containing no WDGS, G:F increased quadratically ($P < 0.01$). A positive associative effect was observed due to the quadratic improvement in G:F as SFC replaced DRC in diets with 0% WDGS. Cattle fed diets containing 35% WDGS with varying SFC:DRC ratio did not respond quadratically ($P = 0.24$) for G:F as SFC replaced DRC. Steers fed SFC with 35% WDGS had only a 2% increase in G:F (0.193) compared with cattle fed DRC with 35% WDGS (0.189), which was not significant. Wet distillers grains appears to eliminate any positive associative effect that may occur when combining SFC and DRC in finishing diets. Final BW, DMI, and ADG decreased quadratically ($P < 0.05$) as SFC replaced DRC in diets containing 35% WDGS. Intake also decreased quadratically ($P < 0.01$) as SFC replaced DRC in diets containing no WDGS.

Key Words: beef cattle, corn Processing, distillers grain

300 Effects of feeding a combination of modified distillers grains plus solubles and wet corn gluten feed compared to forage for grain adaptation to finishing diets on performance. M. G. Dib*¹, B. L. Nuttelman¹, W. A. Griffin¹, G. E. Erickson¹, T. J. Klopfenstein¹, and R. U. Lindquist², ¹University of Nebraska, Lincoln, ²Archer Daniels Midland, Columbus, NE.

A feedlot experiment was conducted to evaluate using a combination of modified distillers grains and wet corn gluten feed versus forage for beef cattle adaptation to finishing diets. The control strategy (CON) utilized 4 adaptation diets that contained 45, 35, 25, 15, and 7.5% alfalfa hay fed for 5, 5, 7, and 7 d until reaching the finishing diet (7.5% alfalfa hay). A combination of modified distillers and wet corn gluten feed (Synergy) comprised 35% of the diet throughout the adaptation, therefore, alfalfa hay was replaced by increasing corn. The other treatment (SYN) was an adaptation strategy that utilized byproducts instead of alfalfa hay. Alfalfa hay was constant at 7.5% of the diet throughout adaptation; however, Synergy was fed at 87.5, 74.4, 61.3, 48.1, and 35% for 5, 5, 7, and 7 d. After the 24-d adaptation period, both treatments were finished on a common finishing diet containing 35% Synergy, 52.5% corn, 7.5% alfalfa, and 5% supplement for 120 additional d. The study was an RCBD with 4 BW blocks with 8 pens per treatment, and 14 to 15 steers (initial BW = 429 kg) per pen. Steers were assigned randomly within block to pens, and pens assigned randomly to the 2 adaptation strategies. Following the adaptation period, cattle were weighed to determine impact on performance. Steers adapted using SYN strategy consumed 0.4 kg/d less DM ($P < 0.01$) compared with CON, but had similar ADG ($P = 0.28$). Therefore, steers adapted using SYN had greater G:F ($P = 0.04$) compared with CON during the adaptation period. Intake, ADG, and G:F were similar ($P > 0.20$) between SYN and CON over the entire feeding period. Similarly, no differences were observed ($P > 0.35$) between SYN and

CON for final live BW, HCW, fat depth, or LM area. Marbling score was not different between treatments ($P = 0.17$). These data suggest that using a combination of wet distillers grains and wet corn gluten feed (Synergy) for adapting cattle to finishing diets across 24 d was similar to using more traditional approaches with alfalfa hay in terms of performance and carcass characteristics. Use of byproduct would dramatically decrease forage needed by feedlots if replaced for the adaptation period.

Key Words: adaptation, corn co-products, feedlot cattle

301 Effect of feeding micro-aid® in diets containing wet distillers grains plus solubles to finishing cattle on performance and nutrient mass balance. A. J. Doerr*¹, W. A. Griffin¹, B. L. Nuttelman¹, G. E. Erickson¹, T. J. Klopfenstein¹, J. R. Benton¹, and M. J. Rincker², ¹University of Nebraska, Lincoln, ²DPI Global, Porterville, CA.

Ninety-six calves (302 ± 11 kg) were stratified by BW, and assigned randomly to 12 pens to evaluate the impact of feeding Micro-Aid® in diets containing wet distillers grains plus solubles (WDGS) to finishing cattle on performance and N mass balance. Micro-Aid® is manufactured from an all natural, plant extract, which contains saponins that have natural detergent and surfactant properties. Steers were fed for 180 d from November to May. Dietary treatments consisted of 35% WDGS, 55% corn, 5% straw, and 5% supplement (CON), with Micro-Aid® being added in the treatment supplement at an inclusion of 1g per steer daily (TRT). Nitrogen excretion was determined by the difference between N intake and individual steer N retention. Total N lost was calculated by subtracting manure and runoff N from excreted N. Intake, ADG, and G:F were similar among treatments ($P \geq 0.65$), as well as carcass characteristics. Nitrogen intake, retention, and excretion were also similar ($P \geq 0.67$). However, amount of total N in manure ($P = 0.02$) was greater for steers fed Micro-Aid® (27.2 kg) than the CON group (18.4 kg). N runoff was not different ($P = 0.92$) between treatments at 2.57% of N excretion. The amount of N lost via volatilization was greater ($P = 0.05$) for the CON cattle (21.3 kg) than the Micro-Aid® treatment (13.8 kg). Therefore, the percent N loss expressed as a percentage of N excretion was greater ($P = 0.04$) for the CON group (52.2%) compared with the TRT diet (34.0%). Organic matter removed was greater ($P = 0.02$) for cattle fed Micro-Aid® (535 kg/steer) than the CON group (370 kg/steer). Performance and carcass characteristics were similar between the CON and TRT cattle. However, inclusion of Micro-Aid® in the diet decreased N volatilization, due to an increase in manure N and OM, which led to reduced N losses.

Key Words: nitrogen, Micro-Aid®, saponins

302 Comparison of bunk and ground feeding of distillers dried grains to growing cattle. W. J. Sexten,* C. C. Stith, and R. L. Kalenbach, University of Missouri, Columbia.

The experimental objective was to evaluate fall-born crossbred beef calf performance when supplements are fed in a feed bunk or on the ground while grazing tall-fescue pastures. Feeding systems evaluated were bunk-fed (BNK), ground-fed (GRD) or not-fed (CON) distillers dried grains with solubles (DDGS) supplement. Meal-form DDGS supplement was fed on alternate days at the equivalent of 1.16 kg \cdot hd⁻¹ \cdot d⁻¹ of supplemental DM. BNK were fed in concrete bunks 2.44 m in length while GRD were fed on the ground in 2 equal piles spaced >4.6 m apart. Calves (n = 58) were stratified by sex and sire breed and randomly assigned to pasture replicates (n = 12). Pastures

were either >80% (H) or <30% (L) endophyte infected resulting in 2 replicates per feeding system and infection level combination. Calves (204.4 ± 35.7 kg) were stocked on 29 April 2009 at 4 or 5 head per replicate resulting in 0.18 ha / calf. Pastures were subdivided into 4 paddocks and rotationally grazed during the 85 d experiment. Two paddocks in each pasture were harvested as hay on 20 May 2009. Data were analyzed as a completely randomized design with a 3x2 factorial arrangement using the mixed procedure of SAS. Single df orthogonal contrasts were used to separate feeding system effects. Feeding system by endophyte infection interaction ($P > 0.10$) was removed from the model. Supplemented calves had greater ($P = 0.01$) ADG (0.89 kg / d) than CON (0.70 kg / d) resulting in supplemental G:F of 0.16. ADG did not differ ($P = 0.27$) between BNK (0.92 kg / d) and GRD (0.85 kg / d). H pastures reduced ($P = 0.02$) ADG by 0.15 kg / d compared with L pastures (0.90 kg / d). Feeding meal-form DDGS supplements on the ground in piles resulted in comparable performance of calves grazing fescue pastures. Future work should evaluate nutrient concentration and forage cover near feed bunks in addition to supplementation frequency and volume.

Key Words: beef cattle, supplementation, feeding system

303 Comparing different drying methods for distillers grains and its effects on feedlot cattle performance. B. L. Nuttelman,* W. A. Griffin, G. E. Erickson, and T. J. Klopfenstein, *University of Nebraska, Lincoln.*

Calf-fed steers ($n = 420$; 305 ± 21 kg) were utilized in a RCBD to determine the feeding value of distillers grains plus solubles (DGS) as a result of different drying methods. Five different types of DGS produced were: 1) WDGS – solubles were added to wet grains (34.5% DM); 2) DDGS – solubles were added to wet grains and dried (89.4% DM); 3) DDG – wet grains were dried with no solubles (90.1% DM); 4) MDGSPre – solubles were added to wet grains and dried (53.3% DM); 5) MDGSPost – wet grains were partially dried and solubles were added to the partially dried grains (42.1% DM). Steers were stratified within block, and assigned randomly to one of 42 pens (10 steers/pen) assigned to one of 7 treatments. Treatments consisted of: 1) corn-based control (CON); 2) WDGS; 3) MDGSPre; 4) MDGSPost; 5) DDGS; 6) DDGS + H₂O; and 7) DDG + Solubles. Distillers grains were included in the diet at 35% of the diet DM. Water was added to DDGS to bring the ingredient DM equal to the MDGSPost. Corn consisted of a 1:1 ratio of high-moisture:dry-rolled corn, and all diets contained 4.1% grass hay, 4.1% sorghum silage, and 5.0% supplement. Daily gain was similar for cattle on diets containing DGS, but was less for CON ($P < 0.01$). Steers fed CON had the lowest DMI ($P < 0.01$), and DDG + Solubles had the greatest DMI, but was not different from DDGS ($P = 0.07$). Cattle fed WDGS had greatest G:F, but were not different from steers fed MDGSPre or MDGSPost ($P > 0.23$). Both MDGSPre and MDGSPost gained as efficiently as DDGS + H₂O ($P > 0.19$), but were greater than CON, DDGS, and DDG + Solubles ($P < 0.03$). When compared with DDGS and DDG + Solubles ($P = 0.07$), G:F tended to be less for CON, but was not different for DDGS and DDG + Solubles ($P = 0.99$). Cattle fed DGS diets gained more, and as a result had heavier HCW ($P < 0.01$). Cattle fed diets containing DGS were fatter at harvest than CON ($P = 0.02$). There were no differences for marbling score or LM area ($P > 0.32$). Drying the solubles onto DG does not explain this change in feeding value.

Key Words: dried distillers grains plus solubles, finishing cattle, wet distillers grains plus solubles

304 Prevalence of *Escherichia coli* O157 in cattle fed distillers grains in Minnesota feedlots. J. M. Popowski,* R. C. Fink, J. P. Jaderborg, D. M. Paulus, K. M. McClelland, J. L. Dahlberg, G. I. Crawford, A. DiCostanzo, R. B. Cox, and F. Diex-Gonzalez, *University of Minnesota, Twin Cities.*

As the ethanol industry grew it was suggested that feeding distillers grains, a byproduct of the ethanol production process, caused an increase in the prevalence of *E. coli* O157:H7 in cattle. Previous research has yielded inconsistent results regarding this effect attributed to feeding distillers grains. The objective of this research was to determine if distillers grains affects the prevalence of *E. coli* O157:H7 in Minnesota feedlot cattle. Three farm sites were evaluated, comprising a one-time capacity of approximately 7,000 cattle. The feedlots evaluated represented a wide variety of facility types (open, enclosed, slatted-floor) and cattle types (calves and yearlings). Multiple pens of cattle within each site were sampled. Fresh fecal samples ($n = 988$) were collected randomly from the feedlot floor at 5 percent of the pen population at least once a month for a year. *E. coli* O157:H7 was determined using a combination of EC broth enrichment, immunomagnetic separation, plating onto sorbitol MacConkey plates and confirmation of isolates by an immunoassay and a multiplex PCR analysis of virulence-specific genes. Results indicated an overall *E. coli* O157:H7 prevalence of 4.15% when averaged across the 3 farm sites. Prevalence within the 3 sites measured 1.03, 5.89, and 6.38%. No difference ($P > 0.27$) was observed for the probability of *E. coli* O157:H7 in cattle fed high (greater than 25.5% dietary DM inclusion) and low (less than 25% dietary DM inclusion) dietary inclusions of distillers grains (0.8 and 0.3% respectively). Dietary inclusion level of distillers grains did not affect *E. coli* O157:H7 prevalence in Minnesota-fed feedlot cattle.

Key Words: *Escherichia Coli* O157:H7, distillers grains, beef

305 The prevalence of *Escherichia coli* O157:H7 in cattle fed distillers grains and harvested through a commercial abattoir in Minnesota. R. C. Fink,* J. M. Popowski, J. P. Jaderborg, D. M. Paulus, K. M. McClelland, J. L. Dahlberg, G. I. Crawford, A. DiCostanzo, R. B. Cox, and F. Diex-Gonzalez, *University of Minnesota, Twin Cities.*

Recent foodborne outbreaks in the United States have been the result of contamination with *Escherichia coli* O157:H7 shedding. Several reports have suggested that feeding distillers grains increases *E. coli* O157:H7 prevalence in cattle, however previous research has shown inconsistent results. The objective of this study was to determine the prevalence of *E. coli* O157:H7 in cattle fed distillers grains in the upper Midwest and harvested at a commercial abattoir in Minnesota. Fresh fecal samples ($n = 856$) were collected randomly once a month for a year. Samples were collected from the rectal area of the animal before hide removal. The total population sampled consisted of 4,185 hd of cattle and 59 lots. *E. coli* O157:H7 was determined using a combination of EC broth enrichment, immunomagnetic separation, plating onto sorbitol MacConkey plates and confirmation of isolates by an immunoassay and a multiplex PCR analysis of virulence-specific genes. The overall *E. coli* O157:H7 prevalence was 11.7% when averaged across all samples. The probability of *E. coli* O157:H7 in cattle fed distillers was lower ($P < 0.0001$) than cattle not fed distillers grains (0.2 and 0.7%, respectively). Season had no effect on the prevalence of *E. coli* O157:H7 in cattle fed distillers grains and no distillers grains for Fall, Spring, and Winter ($P = 0.82, 0.23, \text{ and } 0.29$ respectively). There was a seasonal trend with Spring and Fall being similar and Winter tending to be lower for prevalence of *E. coli* O157:H7 (4.56, 4.82 and 1.36%, respectively). Results from this study indicate that inclusion of distill-

ers grains in beef cattle feedlot diets resulted in decreased prevalence of *E. coli* O157:H7 from fecal samples collected at a Minnesota commercial abattoir.

Key Words: *Escherichia Coli* O157:H7, distillers grains, beef

306 Comparison of feedlot cattle performance when fed silage and grain from second-generation insect-protected corn (MON 89034), parental line, or reference hybrids. B. M. Weber*¹, B. L. Nuttelman¹, G. E. Erickson¹, T. J. Klopfenstein¹, W. A. Griffin¹, J. R. Benton¹, and T. H. Klusmeyer², ¹University of Nebraska, Lincoln, ²Monsanto Company, St. Louis, MO.

Two-hundred 40 crossbred steer calves (290 ± 14 kg) were used in a finishing experiment (175 d) to compare the feeding value of corn grain and corn silage from a second generation insect protected (Bt) hybrid (MON 89034) with a non-transgenic parental hybrid and 2 commercially available reference hybrids. Twenty-four pens were used in a RCBD with 2 blocks, 6 pens/treatment and 10 steers/pen. Diets contained 65% dry rolled corn and 15% corn silage from either the test hybrid (MON), a near isogenic parental hybrid (CON), or 2 commercially available reference hybrids (REF1 and REF2), as well as 15% WDGS and 5% supplement. Corn was grown and stored under identity preserved methods. Corn silage was grown and stored in silo bags under identity preserved methods as well. Initial BW was 1.3 kg different, albeit significant ($P = 0.02$). Therefore, initial BW was used as a covariate. Intake ($P = 0.96$) and ADG ($P = 0.31$) were not different across treatments. Feed efficiency was similar across hybrids ($P = 0.13$), with 0.168, 0.164, 0.171, and 0.165 for MON, CON, REF1, and REF2, respectively. No differences were observed in HCW ($P = 0.93$), marbling score ($P = 0.55$), 12th rib fat thickness ($P = 0.82$), LM area ($P = 0.70$), and calculated YG ($P = 0.78$). Source of corn had no significant effect ($P > 0.13$) on the performance or carcass characteristics of steers in this trial, and suggest that the second-generation insect-protected hybrid (MON 89034) is nutritionally equivalent to conventional, non-transgenic corn grain and corn silage when fed to finishing steers.

Key Words: cattle, Ffinishing, transgenic plant, corn

307 Performance of growing cattle fed corn silage from second-generation insect-protected corn (MON 89034) compared to parental line or reference hybrids. B. M. Weber*¹, B. L. Nuttelman¹, G. E. Erickson¹, T. J. Klopfenstein¹, W. A. Griffin¹, J. R. Benton¹, and T. H. Klusmeyer², ¹University of Nebraska, Lincoln, ²Monsanto Company, St. Louis, MO.

Two-hundred 40 steer calves (279 ± 20 kg) were used in an experiment (86 d) to compare the feeding value of corn silage from a second-generation insect protected (Bt) corn hybrid (MON 89034) with a non-transgenic parental hybrid (CON) and 2 non-transgenic commercially available reference hybrids (REF1 and REF2). Twenty pens were used in a RCBD with 2 blocks, 5 pens/treatment and 12 steers/pen. Diets

contained 80% corn silage from either MON, CON, REF1, or REF2, as well as 15% WDGS and 5% supplement. Corn silage was grown and stored in silo bags under identity preserved methods. Initial BW was 1.7 kg different, but was significant ($P = 0.01$). Therefore, initial BW was used as a covariate. Intake was similar across hybrids ($P = 0.40$) with 9.3, 9.4, 9.5, and 9.4 kg/d for MON, CON, REF1, and REF2, respectively. No differences were observed in ADG ($P = 0.56$) between treatments, with steers fed MON gaining 1.65 kg/d, compared with CON steers gaining 1.64 kg/d, REF1 steers gaining 1.65 kg/d, and REF2 steers gaining 1.61 kg/d. Feed efficiencies were 0.178, 0.174, 0.174, and 0.170 for MON, CON, REF1, and REF2, respectively, and did not differ ($P = 0.25$). Source of corn silage had no significant effect ($P > 0.25$) on the performance of steers in this trial, and suggest that the second-generation insect-protected hybrid (MON 89034) is nutritionally equivalent to conventional, non-transgenic corn silage when fed to growing steers.

Key Words: cattle, growing, transgenic plant, corn silage

308 Economic returns for feeding distillers grains plus solubles. C. D. Buckner,* T. J. Klopfenstein, G. E. Erickson, D. R. Mark, and V. R. Bremer, University of Nebraska, Lincoln.

An economic budget model based on cattle performance, feed ingredient costs, feeding and trucking costs, interest, and yardage expenses called Cattle CODE was used to evaluate economic differences in 4 scenarios for feeding distillers grains plus solubles (DGS) to finishing cattle. Wet distillers grains plus solubles (WDGS) was priced at 60 and 90% of the price of corn using corn prices of \$4 and \$6/ bushel and hauled 30 miles to the feedlot. This resulted in positive economic returns compared with feeding no WDGS and profits increased as corn prices increased and as price of WDGS relative to corn decreased. Greater economic returns were observed as dietary inclusion of WDGS increased up to 50% DM when WDGS was priced at 60% the price of corn. Using \$5/ bushel corn and WDGS at 75% the price of corn resulted in decreased economic returns for transporting WDGS 130 miles to the feedlot compared with 30 miles, but optimum inclusion remained at 40% diet DM for 130 miles. Dry distillers grains plus solubles (DDGS), modified distillers grains plus solubles (MDGS), and WDGS and were evaluated based on being priced equal to each other at 75% the price of corn, or added cost of drying the product to the modified or dry form. These scenarios used \$5/ bushel corn price and 0 miles for hauling the DGS. Returns were greatest for WDGS and least for DDGS due to cattle performance when DGS were priced equal to each other. When drying costs were added to MDGS and DDGS, marginal economic returns for feeding WDGS were greater compared with MDGS and DDGS than when DGS were priced equal. Feeding WDGS typically results in greater economic returns compared with MDGS and DDGS (\$10 to \$30/ head) and these returns are \$40 to \$120/ head greater than feeding corn at inclusions of 30 to 50% diet DM, but returns are dependent on price of corn and price of WDGS.

Key Words: cattle, distillers grains, economics

Ruminant Nutrition I

309 (Invited ASAS Animal Science Young Scholar) Factors influencing sulfur toxicity in ruminants fed distillers dried grains with solubles. B. W. Neville^{*1}, G. P. Lardy¹, K. K. Karges³, P. T. Berg¹, and C. S. Schauer², ¹North Dakota State University, Department of Animal Sciences, Fargo, ²Hettinger Research Extension Center, North Dakota State University, Hettinger, ND, ³Dakota Gold Research Association, Sioux Falls, SD.

One challenge with using ethanol co-products is potential for increased dietary S concentration which has been implicated as a cause of polioencephalomalacia (PEM) in ruminants. The focus of this research was to evaluate PEM in ruminants fed distillers dried grains with solubles (DDGS). Two separate hypotheses were formed: 1) Providing increased dietary thiamin would decrease incidence of PEM in lambs fed increased S diets without affecting animal performance; and 2) Feeding DDGS would increase concentrations of H₂S and incidence of PEM compared with dry-rolled corn based diets. Studies were conducted utilizing lambs to evaluate the influence of increasing supply of dietary thiamin (0, 50, 100, or 150 mg/d) on performance and incidence of PEM as well as the impact of DDGS (0, 20, 40, or 60% DM basis) on sulfur balance. Beef steers were utilized to examine the influence method of corn processing (high-moisture vs. dry-rolled corn) and DDGS concentration (20, 40 or 60% DM basis) have on animal performance, H₂S concentrations, and incidence of PEM. Hydrogen sulfide concentrations were measured via rumenocentesis as lambs and steers were adapted from receiving to finishing diets. No differences in lamb performance were noted ($P \geq 0.17$). Sulfur excretion increased ($P \leq 0.01$) with increasing dietary DDGS. Steer performance decreased ($P \leq 0.02$) with increasing concentration of DDGS. Lambs fed 150 mg of thiamin and steers fed 60% DDGS had the greatest concentrations of H₂S (1.07 g H₂S /m³ ($P \leq 0.009$) and 1.38 g H₂S /m³ ($P \leq 0.01$), respectively). Ruminal H₂S concentrations in steers were affected by increasing DDGS concentration in the diet ($P < 0.001$), but not corn processing method ($P = 0.94$). The use of thiamin as a dietary additive to aid in prevention of PEM in finishing lambs does not appear to be necessary under the present conditions. There are many questions about the role dietary S from DDGS plays in incidence of PEM as we detected no cases of PEM when dietary S concentrations exceeded 2 to 3 times maximum tolerable level. Additional research is needed to clarify differential species responses.

Key Words: distillers dried grains with solubles, polioencephalomalacia, sulfur

310 Factors affecting ruminal hydrogen sulfide concentration of cattle. M. E. Drownoski,^{*} D. C. Beitz, D. D. Loy, S. M. Ensley, and S. L. Hansen, Iowa State University, Ames.

Increased ruminal hydrogen sulfide (H₂S) concentrations have been associated with polioencephalomalacia (PEM). Objectives of this study were to determine the effects of dietary sulfate, time of sampling relative to feeding, and rumen cannulation (C) on ruminal H₂S. Sixteen steers (8 cannulated; 355 kg; and 8 unmodified; 386 kg) were used in a 2x2 factorial design with the 2 factors being C status and dietary treatment (trt). Dietary trt consisted of a low sulfate (0.2% S; LS) wheat mid-based pellet or LS plus sodium sulfate to achieve a high sulfate (0.7% S; HS) pellet. Steers were blocked to pairs by C and BW and pair-fed between trt. The HS steers were fed 110% of the previous day's intake of pellets and the LS steers were pair-fed 105% of the intake of their HS counterpart. All steers were fed chopped bro-

megrass hay at 5% of pellet intake. As designed, daily DM intake did not differ ($P = 0.80$) between trt (6.08 vs 6.15 kg/hd for LS and HS, respectively). Ruminal gas was sampled from all cattle on d 1, 4, 8, 15, 18, and 22 at 8 h post-feeding. Kitagawa detector tubes were used to measure H₂S. At 8 h post-feeding, H₂S was not affected by C ($P = 0.35$) but was greater ($P < 0.01$) in HS (6005 ± 475 ppm) than LS (1639 ± 472 ppm). Serial H₂S measures were collected from cannulated steers pre-feeding and 2, 4, 6, 8, 10, 12, 16, and 20 h post-feeding on d 18. Timing of sampling relative to feeding affected ($P = 0.01$) H₂S, suggesting that time of sampling should be considered when comparing H₂S data among studies, assessing risk for developing PEM, and diagnosing clinical cases of PEM.

Table 1. Ruminal gas H₂S (ppm) relative to time of feeding

Treatment	0 h	2 h	4 h	6 h	8 h	10 h	12 h	16 h	20 h
LS	307 ^e	1938 ^{de}	2388 ^{de}	2300 ^{de}	1638 ^{de}	2238 ^{de}	2233 ^{de}	1208 ^{de}	713 ^e
HS	2589 ^{cd}	5938 ^b	7813 ^{ab}	8597 ^a	4188 ^c	8375 ^a	7625 ^{ab}	1950 ^{de}	3712 ^{cd}
SE	1035	1011	1011	1035	1011	1297	1011	1011	1035

^{a-e} means lacking common superscripts differ ($P < 0.05$).

Key Words: hydrogen sulfide, cattle

311 Determining a safe level of ruminal hydrogen sulfide gas. C. A. Nichols,^{*} K. M. Rolfe, C. D. Buckner, G. E. Erickson, and T. J. Klopfenstein, University of Nebraska, Lincoln.

The objective of the current study was to compare ruminal hydrogen sulfide levels of steers fed diets that have induced polio in feedlot cattle to diets that have not induced polio. Five ruminally fistulated steers fitted with rumen gas extraction cannula plugs were utilized to quantify ruminal pH and hydrogen sulfide (H₂S) levels produced at different times post feeding. Diets consisted of 1) 28.5% WDGS, 37.5% Sweet Bran, 25% DRC, 4% Corn Bran, 0% alfalfa hay; 2) 28.5% WDGS, 37.5% Sweet Bran, 17.5% DRC, 7.5% alfalfa, and 4% Corn Bran; 3) 44% WDGS, 44% Sweet Bran, 7.5% alfalfa; 4) 50% WDGS, 37.5% DRC, 7.5% alfalfa; 5) 87.5% Sweet Bran, 7.5% Alfalfa. All diets contained 5% (DM basis) supplement. Diets 1 and 3 have induced polio in past feeding trials. Steers fed diet 2 (28.5%WDGS, 37.5%Sweet Bran, 7.5% alfalfa) consumed more feed (11.3 kg) compared with cattle fed diet 3 (10.2 kg; 44%WDGS, 44%Sweet Bran; $P = 0.05$). Steers fed diets containing 44% WDGS and 44% Sweet Bran had greater ($P < 0.01$) levels of H₂S (61.1 μmol H₂S/L) compared with other diets; however, cattle fed 87.5% Sweet Bran produced less ($P < 0.05$) H₂S (32.3 μmol H₂S/L) compared with the other 4 dietary treatments. Ruminal hydrogen sulfide levels for diets 1 (28.5%WDGS, 37.5%Sweet Bran, no alfalfa), 2 (28.5%WDGS, 37.5%Sweet Bran, 7.5% alfalfa), and 4 (50%WDGS) were 46.2, 48.4, and 50.3 μmol H₂S/L respectively, and were not different ($P > 0.05$). The dietary sulfur level of diet 1, 2, 3, 4, and 5 were 0.45, 0.46, 0.58, 0.45, and 0.46% (DM basis) respectively. Average, maximum, and variance ruminal pH was not affected by treatment; however, time <5.6 was greater ($P = 0.03$) for diet 1 compared with diets 2, 3, and 5. Finishing diets that promote the production of ruminal hydrogen sulfide levels at or below what was produced by diet 5 (32.3 μmol H₂S/L, $P < 0.05$) would be considered low risk for provoking polio in feedlot cattle whereas hydrogen sulfide levels above 50 μmol H₂S/L would be considered high risk.

Key Words: beef cattle, sulfur, hydrogen sulfide

312 In vitro effect of starch and sulfur on rumen gas production and hydrogen sulfide release. M. Ruiz Moreno,* E. Seitz, G. Crawford, A. DiCostanzo, and M. D. Stern, *University of Minnesota, St. Paul.*

An in vitro rumen fluid (RF) incubation was conducted using 3 concentrations of sulfur (S) and 3 concentrations of starch in a 3 × 3 factorial arrangement of treatments during 2 consecutive 24-h periods. Nine synthetic diets with starch concentrations of 5, 35, or 60% of DM and S concentrations of 0.3, 0.4, and 0.5% of DM were prepared. Crude protein, fat and microminerals + vitamins were fixed at 12, 3.5 and 0.5%, respectively. Purified cellulose comprised the balance of each diet. Ruminant fluid was obtained from a cannulated lactating dairy cow and mixed with McDougall's artificial saliva to a 2:1 ratio. Approximately 0.5 g of substrate DM and 50 mL of RF + saliva were incubated in crimp-sealed, 125 mL serum bottles (n = 36; 4 reps/treatment) at 39°C. At 5 and 24-h post-inoculation, gas production was measured and a subsample of headspace gas was analyzed for hydrogen sulfide (H₂S). Increasing concentrations of starch resulted in increased ($P < 0.05$) final pH, averaging 5.88, 5.91, and 5.93 for 5, 35, and 60% starch, respectively. Sulfur concentration did not affect ($P > 0.05$) final pH of incubations, averaging 5.91 ± 0.004 , or total gas production, averaging 248 ± 0.6 mL across treatments. Total gas production increased ($P < 0.05$) with increasing starch concentration at 236, 250 and 259 mL for 5, 35 and 60% starch, respectively. Increasing concentrations of starch increased ($P < 0.05$) the amount of gas produced during the first 5 h of fermentation (106, 137, and 154 mL for 5, 35, and 60% starch, respectively) and decreased ($P < 0.05$) the amount of gas during the last 19 h of fermentation (130, 113, and 104 mL for 5, 35 and 60% starch, respectively). Total release of H₂S was not affected ($P > 0.05$) by S concentrations, averaging 969 ± 11 µg, but 5% starch resulted in lower H₂S release ($P < 0.05$) compared with 35 or 60% at 936 vs. 987 or 983 µg respectively, suggesting a plateau in H₂S release. Results suggest that H₂S production is affected by starch concentration but not by the S concentrations evaluated in this study.

Key Words: *in vitro*, hydrogen sulfide, rumen

313 High dietary sulfur modifies volatile fatty acid profiles and increases hydrogen sulfide gas production. E. L. Richter*¹, M. E. Drewnoski¹, C. J. Ziemer², and S. L. Hansen¹, ¹*Iowa State University, Ames*, ²*USDA-ARS, Ames, IA*.

Crossbred yearling steers (n = 96; 321 kg BW) were used in a 155 d study to determine the effects of dietary sulfur (S) from dried distillers grains (DDGS) on rumen microbial populations and the rumen environment. Steers were blocked by weight and supplemented at 1% BW with either low S DDGS (0.3% S; LS; n = 48) or LS DDGS plus 0.3% S from sodium sulfate (HS; n = 48) for 35 d on pasture (n = 4 plots/diet). From d 36–67 steers transitioned to a finishing diet with half remaining on their previous diet and half switching treatments, resulting in 4 treatments. Pasture diet did not affect feedlot measures, thus main effects are reported. Steers were housed in pens of 4 with 6 pens per treatment. Rumen fluid was collected via esophageal intubation and rumen gas cap measurements for hydrogen sulfide were taken at critical dietary time points, and d 155. Rumen fluid was analyzed for volatile fatty acids and lactate. Dry matter intake did not differ ($P = 0.15$) due to S. On d 155 dietary S concentration reduced ($P < 0.01$) the proportion of isovalerate (1.45% for LS and 0.58% for HS) and tended ($P \leq 0.10$) to reduce acetate proportion (47.5% for LS and 44.4% for HS). Proportion of propionate tended ($P \leq 0.10$) to be higher in HS (41.4%) vs. LS (36.1%). Lactate did not differ due to S ($P = 0.53$). On d 155 ruminal hydrogen sulfide concentrations were greater ($P < 0.01$)

in HS (5275 ppm) compared with LS (1248 ppm). Microbial DNA was isolated from rumen fluid and analyzed by real time quantitative PCR to determine if primer sets previously used in swine slurry would detect sulfate reducing bacteria (SRB) in rumen fluid. Desulfobivrio-like organisms were specifically targeted using the primer sets and were found in both HS and LS fluid with an average copy number per mL of rumen fluid of 2.5×10^4 and PCR efficiency of 89.9%. Utilizing molecular techniques may aid elucidation of unculturable SRB populations and their response to changes in dietary composition and S concentration.

Key Words: cattle, sulfur, microbes, rumen

314 Chemical treatment to enhance crop residue use in finishing cattle diets. A. L. Shreck*¹, B. L. Nuttleman¹, W. A. Griffin¹, G. E. Erickson¹, T. J. Klopfenstein¹, and M. J. Cecava², ¹*University of Nebraska, Lincoln*, ²*ADM Research, Decatur, IL*.

Increased nutrient utilization of chemically treated crop residues has been well documented but research related to value and inclusion in feedlot diets is lacking. A finishing experiment utilizing 336 short-yearling steers (initial BW = 356 ± 11.5 kg) was conducted to evaluate the efficacy of feeding chemically-treated crop residues to replace corn in a feedlot diet based on corn and wet distillers grain with solubles (WDGS). A RCBD experiment with a 2X3+1 factorial arrangement of treatments was used. Crop residues (corn cobs, wheat straw, and corn stover) replaced corn and were fed at 20% of diet DM in their native form (native) or stored anaerobically at 50% DM with 5% CaO (treated). All diets contained 40% WDGS and 4% supplement (DM basis). A control (CON) was included that contained 10% roughage (equal parts cobs, straw, and stover) and 46% DRC. Cobs were ground smaller than (1.27 cm screen) straw and stover (7.62 cm screen). Steers were stratified and blocked (n = 3) by BW and assigned randomly to 42 pens, with 8 steers per pen. The interaction between chemical treatment and residue (2X3 factorial) was significant for final BW, ADG, and HCW. Greater final BW and HCW ($P < 0.01$) were observed for treated stover (4.6%) and straw (5.6%) compared with native residues; however no difference was observed between treated and native cobs. Treated stover and straw had 9.7% and 12.5% greater ADG ($P < 0.01$) compared with native forms. Chemical treatment improved ($P < 0.01$) G:F compared with native; however, treated roughages were not different from the CON. Chemical treatment increased ($P < 0.01$) 12th rib fat and tended to increase ($P = 0.08$) calculated yield grade. Marbling score and DMI were not different across treatments. Feeding chemically treated crop residues in WDGS-based finishing diets is an effective strategy to partially replace additional corn without compromising performance or carcass quality.

Key Words: calcium oxide, crop residues, distillers grains

315 Apparent digestibilities of nutrients in lactating dairy cows fed a hemicellulose extract. K. J. Herrick*¹, M. Abdullah², A. R. Hippen¹, K. F. Kalscheur¹, D. J. Schingoethe¹, and R. S. Patton³, ¹*South Dakota State University, Brookings*, ²*University of Veterinary and Animal Sciences, Lahore, Pakistan*, ³*Temple Inland, Inc.*

Hemicellulose extracts contain large amounts of hexose and pentose sugars and have historically been used in dairy cow diets as a substitute for molasses products. Previous in situ work from our lab indicated improved ruminal fiber disappearance characteristics associated with feeding a hemicellulose extract. It was the objective of this research to identify the relationship of hemicellulose extract supplementation on

digestibility parameters in lactating dairy cows. Eight multiparous and 4 primiparous Holstein cows (142 ± 44 DIM, 685 ± 19 kg BW) including 4 with ruminal fistula were used in a 2×2 Latin square with 21-d periods. Cows were fed a control diet containing 55% forage (DM basis, 2/3 corn silage and 1/3 alfalfa hay) or a similar diet where 1.0% of the diet forage DM was replaced with the extract. Titanium dioxide was used as a marker and was top-dressed to each cow's ration for the last 7 d of each period. A total of 12 fecal samples from each cow were collected at staggered 6-h intervals during the last 3 d of each period. Apparent dry matter digestibility averaged 68.5 and 67.8% for the treatment diet and control diet respectively, and was not affected by treatment. Addition of the hemicellulose extract to the diet increased ($P = 0.03$) apparent NDF digestibility with cows fed the treatment diet averaging 48.1% compared with 38.6% for the control diet. There were no significant effects for apparent ADF digestibility (43.3 vs. 37.1%), apparent CP digestibility (67.9 vs. 67.2%), and apparent starch digestibility (92.8 vs. 92.2%) between the treatment and control diets. All digestibility estimates except apparent starch digestibility were significantly ($P < 0.01$) lower for the second period compared with the first period. This was thought to be a result of elevated temperature and humidity and decreased feed intake that occurred during the final week of the second period. Results demonstrated that supplementing diets of lactating dairy cows with a hemicellulose extract improves NDF digestibility and has the potential to improve animal performance.

Key Words: hemicellulose extract, digestibility

316 In Vitro digestibility of crop residues and plant parts after chemical treatment and anaerobic storage. A. L. Shreck*¹, C. D. Buckner¹, G. E. Erickson¹, T. J. Klopfenstein¹, and M. J. Cecava², ¹University of Nebraska, Lincoln, ²ADM Research, Decatur, IL.

The objective of this study was to evaluate if chemical and temperature treatments improve DM digestibility of crop residues for eventual use in cattle diets. Three experiments were conducted to evaluate efficacy of chemically treating crop residue and plant parts on ruminal in vitro DM digestibility (IVDMD). Experiment 1 was a $3 \times 4 \times 2$ factorial, consisting of 3 forage fractions: corn stover (CS), corn cobs (CC), and wheat straw (WS), 4 levels of alkaline treatment which were control, 5% CaO (5:0), 4% CaO + 1% NaOH (4:1), 3% CaO + 2% NaOH (3:2), and 2 levels of DM (35% or 50%). Experiment 2 was a $3 \times 2 \times 3 \times 2$ factorial with CS, CC, and WS which were treated with 5:0 or 3:2, and stored for 7, 14, or 28 d, at 30°C or 40°C. Experiment 3 was a 6×4 factorial with CS, CC, WS, as well as corn plant parts (leaf, stem, and husk), treated with 5:0, 4:1, 3:2, plus a control. In all experiments, forage, water, and chemical were combined and stored in vacuum sealed plastic bags (3 or 4 replicates per treatment combination). Across experiments, chemical treatment increased IVDMD ($P < 0.001$). Cobs were inherently more digestible than CS and WS. In Exp. 1, DM digestibility was slightly greater (1.14% unit increase, $P < 0.001$) for 50% compared with 35% DM. In Exp. 2, IVDMD was greater (4.10% unit increase) for 3:2 compared with 5:0. In Exp. 2, samples stored at 40°C had 1.02% unit greater ($P < 0.01$) IVDMD compared with 30°C. Samples stored for 7, 14, or 28 d had similar digestibility values ($P = 0.38$). In Exp. 3, IVDMD was different ($P < 0.001$) among husks (64.3%), leaves (49.3%), CC (47.0%), WS (45.0%), CS (39.0%), and stems (35.4%). The average percentage unit (IVDMD) response to chemical treatment was: WS 15.8%, leaves 12.8%, CC 9.7%, CS 8.2%, husks 7.4% and stems 6.8%. Digestibility of crop residues can be improved markedly in relatively short amounts of time by applying modest concentrations of alkaline chemicals at near ambient temperature. Results indicate that substrate DM and reaction temperature can slightly affect the magnitude of response observed for chemi-

cal treatment. The magnitude of response for chemical treatment also was dependent on plant part.

Key Words: chemical treatment, corn plant, digestibility

317 Determining accurate NDF Values for corn and distillers grains plus solubles. C. D. Buckner,* T. J. Klopfenstein, and G. E. Erickson, University of Nebraska, Lincoln.

Six experiments were conducted to determine accurate NDF values for corn and distillers grains plus solubles (DGS) by decreasing factors associated with starch and fat. In Exp. 1 and 2, dry-rolled corn (DRC) and high-moisture corn (HMC) samples were used to evaluate adding sodium sulfite (SS) and α -amylase (AMY) on NDF content. The SS decreased ($P < 0.01$) NDF values and was used throughout subsequent experiments. Adding 2 doses of AMY decreased ($P < 0.01$) NDF values compared with one dose in Exp. 2, but NDF values remained greater than expected. In Exp. 3, the same corn hybrid processed as DRC and HMC was compared with a steam-flaked corn (SFC) sample using 1 to 4 doses of AMY to determine corn NDF. The DRC hybrid had the greatest NDF value compared with HMC and SFC. Adding 2 doses of AMY or more decreased ($P < 0.01$) NDF values compared with 1 dose. However, NDF did not decrease ($P = 0.53$) for using more than 2 doses of AMY, and this method was used in Exp. 4 and 5. Corns from Exp. 3 were used in Exp. 4 and an interaction resulted ($P < 0.01$) between techniques as corns were treated with combinations of AMY and amyloglucosidase (GLU) doses and autoclaved (AUT). Using AUT and GLU did not decrease corn NDF content compared with using AA alone, but no corn NDF values in this Exp. were considered acceptable. Four DRC samples were ground through a 1-mm screen Willey mill (Willey) or Tecator Cyclomill (Cyclo) in Exp. 5. An interaction resulted between sample and grinder type ($P < 0.01$), but using the Cyclo with SS and 2 doses of AMY resulted in acceptable NDF values (9 to 10%). Five DGS samples were used in Exp. 6 to evaluate the traditional NDF beaker method with 100 or 200 mL NDF solution and using a pre-fat solvent extraction step before the traditional method on NDF content for DGS. Using the pre-fat extraction process decreased NDF values ($P < 0.01$) for DGS compared with the traditional methods. We recommend grinding through a Cyclo and using 2 doses of 0.5 mL AMY and SS for corns and using the pre-fat extraction process for DGS to measure NDF appear to be most accurate.

Key Words: corn, distillers grains, fiber

318 Access time to hay feeder by gestating beef cows affects dry matter intake and hay waste. J. Jaderborg,* G. Crawford, and A. DiCostanzo, University of Minnesota, St. Paul.

An experiment was conducted to evaluate how access time to hay feeder by late-gestating beef cows affected cow BW, DMI, and hay waste. Angus cows ($n = 24$, 553 kg) were stratified by BW and age to one of 3 groups. Groups were assigned to one of 3 10-d treatment periods in a 3×3 Latin square design replicated in time. Treatments were access to round-bale hay feeders for 6, 14, or 24 h. Hydraulic-curtain, round-bale feeders, controlled by timers, were used to restrict access time to either 6 or 14 h, while a conventional round-bale feeder permitted 24-h access to hay. Grass hay (9.56% CP, 54.6% TDN) was placed in each feeder when bale was fully consumed or when it appeared it would be consumed overnight. All cows had ad libitum access to a complete loose mineral and salt supplement and water. Cow BW was measured following removal of hay for 12 h to determine group BW

initially, and at the end of each period. Hay waste was measured before a new bale was delivered by collecting and weighing random 0.093 m² samples representing 2% of the waste scatter area. Orthogonal contrasts were used to compare 24-h vs restricted access to hay, and 14-h vs 6-h access to hay. Daily DMI was greatest ($P < 0.0001$) when cows had access to hay for 24 h (12.4 vs 10.3 kg/d). Daily DMI was lowest ($P < 0.0001$) when cows had 6-h access to hay (11.1 vs 9.6 kg/d for 14-h or 6-h access time, respectively). Hay waste (expressed as a percentage of DMI) was greatest ($P < 0.0001$) when cows had access to hay for 24 h (7.7% vs 2.5%). Hay waste was lowest ($P < 0.003$) when cows had 6-h access to hay (4.2% vs. 0.8% for 14-h or 6-h access time, respectively). Cow BW change did not differ ($P > 0.10$) when access was reduced from 14 to 6 h. However, there was a trend ($P = 0.051$) for greater cow BW gain for cows with unrestricted access to hay (23 vs 14 kg). Controlling access to hay reduced DMI and hay waste while permitting cow BW maintenance.

Key Words: hay, intake, beef cows

319 Feeding frequency an arcane strategy: Early lactation cow production. S. M. Karimzadeh and A. Nikkhah,* *University of Zanjan, Zanjan, Iran.*

Dependent on numerous farm, animal and dietary conditions, feeding frequency (FF) is mysterious in dairy cattle management. As such, theories may not hold in practice. The objective was to clarify FF effects on dairy cow performance fed chopped alfalfa hay based total mixed rations (TMR). Eight multiparous early lactation Holstein cows (averaged 577.5 kg BW, 2.5 BCS, and 33.0 kg milk yield) housed in free individual boxes (4 × 3 m) received either once daily (1 ×) at 0700 h or 4 times daily (4 ×) at 0100, 0700, 1300 and 1900 h a TMR. Cows were milked twice daily in a milking parlor. The TMR had forage to concentrate ratio of 38:62, based on alfalfa hay, and barley and corn grains. To minimize cow selection of particular particles, water was spread onto the ration, so the TMR delivered had 81% DM, 17.6% CP, and 27.3% NDF. The study was a 2 × 2 crossover design with 2 periods of 20 d. Each period had 14 d of adaptation. Data were analyzed as a linear mixed model with treatment fixed effect and cow plus period random effects. Once instead of 4 × feeding increased ($P = 0.05$) intakes of DM (21.1 vs. 20.0 kg/d) and NEL (36.4 vs. 34.3 Mcal/d). Orts as a percentage of the TMR fed were similar between 1 × and 4 × groups (7.6 vs. 10%, $P = 0.24$). Milk yield (31.5 vs. 30.7 kg/d, $P = 0.16$), milk NEL output (21.7 vs. 21.4 Mcal/d, $P = 0.72$), fat content (3.5 vs. 3.6%, $P = 0.66$), protein content (3.2 vs. 3.2, $P = 0.81$), milk NEL to intake NEL ratio (0.60 vs. 0.62, $P = 0.35$), milk fat to protein ratio (1.1 vs. 1.2, $P = 0.58$), and fecal pH (6.64 vs. 6.62, $P = 0.67$) were similar between 1 × vs. 4 × feed deliveries. Urine pH was higher with 4 × than 1 ×

feeding (8.12 vs. 8.00, $P < 0.01$). The 4 × cows tended to gain more periodical BCS than 1 × cows (0.25 vs. 0.03 unit, $P = 0.07$), but BW changes were not different (−70 vs. 180 g/d, $P = 0.53$). Results suggest that under uncompetitive individual feeding and housing, more frequent feeding has no productive advantages for early lactation cows. Reduced urine pH by 1 × feeding suggests less alkaline extracellular body fluids. Improved energy intake by 1 × instead of 4 × feeding before DMI peaks possesses metabolic and health implications.

Key Words: feeding frequency, dairy cow, management, production

320 Predictors of transition cow success from a voluntary milking system. R. F. Leuer,* J. K. Reneau, J. M. Lukas, and M. I. Endres, *University of Minnesota, Saint Paul.*

A retrospective study of lactation records ($n = 57$, lactation 1–4) from a Holstein dairy herd in Minnesota with a voluntary milking system was conducted to identify factors that reflect the success or failure of the transition period. Analysis of transition cow productivity early in lactation has the potential to aid in disease diagnosis and monitor management practices. Voluntary milking systems impart many new animal metrics for the herd manager to use. Total milk produced by 100 d was used to evaluate success of the transition period. To identify key metrics that indicate a successful transition period, best subsets regression was used to identify the combination of predictor variables for the first, second, and third week in the lactation. Fit was assessed with Mallows' C_p . For the first week in lactation ($R^2 = 70.1$), predictor variables included were maximum milk production, standard deviation of milk production, standard deviation of milking refusals, maximum concentrate feed allowed, and mean of unconsumed concentrate feed. The second week ($R^2 = 75.1$) predictor variables were minimum milk production, mean of milking refusals, maximum concentrate feed allowed, and mean milk production. Finally the third week ($R^2 = 90.5$) contained predictor variables of minimum daily milk production, minimum daily activity, average weight, mean milk production. All variables chosen for the models were positively correlated with total milk production by 100 d. These data show that additional management information can be deduced from outputs specific to voluntary milking systems to monitor the success or failure of cows as they begin a lactation period. Significant predictors changed week to week, demonstrating the change in the animal's physiology and behavior as the lactation progresses. Future work in developing a transition cow monitoring program for a herd with a voluntary milking system will need to take into account the additional feeding, behavior, and animal weight capabilities available from the milking system.

Key Words: transition cow, voluntary milking system, precision dairy farming

POSTER PRESENTATIONS

Ruminant Nutrition

321 Value of a novel distiller's grain as a protein supplement for gestating beef cows. N. L. Hojer*¹, M. B. Hubert¹, D. L. Gay¹, V. N. Owens¹, A. D. Ressett¹, R. H. Pritchard¹, K. Karges², and K. C. Olson¹, ¹South Dakota State University, Brookings, ²Poet Nutrition, Sioux Falls, SD.

Refinements in ethanol manufacturing create novel co-products. Dry milling to remove the germ and bran of corn grain before fermentation creates distiller's grains with reduced oil and higher CP [deoiled, dried distiller's grains with solubles (dDGS), 42% CP, 80.3% TDN]. Our objective was to determine the suitability of dDGS as an iso-nitrogenous alternative to SBM (51.7% CP, 82.1% TDN) to meet the CP requirement of gestating beef cows consuming low-quality forage. In experiment 1, coming 2- and 3-yr old beef cows (n = 96 in 2008–09, 84 in 2009–10) in the last trimester of gestation were used in a randomized complete block design with a 2 supplement by 2 cow age factorial treatment structure. The study was conducted in 12 drylot pens, creating 3 pen replicates of each supplement by cow age combination. All cows had ad libitum access to low-quality grass straw in 2008–09 (3.2% CP, 47.1% TDN) and a mixture of grass straw and hay in 2009–10 (5.25% CP, 50.5% TDN). Responses measured were body weight and body condition score. In experiment 2, 6 ruminally cannulated 2-yr-old beef cows were used in a completely randomized crossover design to evaluate the influence of dDGS vs. SBM on in situ rate of degradation of grass straw and hay. Cow ADG and BCS change did not differ ($P > 0.17$) between supplements. Final BW and BCS also did not differ ($P > 0.18$). The birth weight of the calves (35.83 kg \pm 0.7165) was not significantly different ($P > 0.05$) between treatments. Protein supplements did not affect ($P > 0.05$) the change in BCS from calving to breeding (-0.28 ± 0.0498). Cow BW (471.518 kg \pm 3.532) and BCS (5.029 \pm 0.0312) also did not differ ($P > 0.05$) among supplements at the time of breeding. There was no difference ($P > 0.05$) in the influence of dDGS vs. SBM on the rate at which grass hay (3.72% \pm 0.5371 and 3.98% \pm 0.6098) and straw (3.26% \pm 0.4516 and 3.94% \pm 0.5075) were digested. In conclusion, dDGS provided similar value to SBM as a protein supplement.

322 A comparison of fecal nitrogen, phosphorous and *E.coli* concentrations from steers fed 0, 25, 40, or 70% modified wet distillers grains. J. L. Veracini*¹, P. M. Walker¹, R. L. Atkinson², J. M. Carmack¹, B. J. Barham¹, and L. A. Forster³, ¹Illinois State University, Normal, IL, ²Southern Illinois University, Carbondale, IL, ³Archer Daniels Midland Co., Decatur, IL.

As the price of shelled corn increases relative to the price of modified wet corn distillers grains (DGS), dietary inclusion of DGS will increase. Studies evaluating the effect of distillers grains on fecal nitrogen (N), phosphorous (P), and *E.coli* (E) have been reported but a paucity of knowledge still exists regarding dietary DGS inclusion above 40%. The objective of this study was to compare the fecal concentrations of N, P and E from steers fed 0, 25, 40, or 70% DGS. Fecal grab samples were collected from 2 steers in each of 80 pens representing 4 feeding trials distributed over 3 years. Nitrogen was determined using a LECO® model FP528 nitrogen determinator. Phosphorous was determined by the nitric acid/ hydrogen peroxide digestion method using an IRIS plasma spectrometer. *E.coli* concentrations were determined and reported as colony forming units per gram (cfu) according to the

method described by BD Diagnostics Systems (2008). Samples identified as positive for *E.coli* were analyzed for presence of 0157:H7. No significant differences in E concentrations due to DGS inclusion were observed (mean = $6.97e+6 \pm 1.82e+6$ cfu) and 91.9% of the fecal samples tested positive for E. Of the positive E samples only 2 tested positive for 0157:H7, both from steers fed 70% DGS with one in December and one in October. Significant differences in E concentration were observed between seasons, with higher concentrations in spring than winter ($7.42e+6$ to $4.70e+6$ cfu). No significant differences in fecal N were observed for steers fed 0, 25, 40, or 70% DGS (mean = $2.15 \pm 0.91\%$). Percent P increased ($P < 0.01$) as percent DGS in the diet increased where 0 DGS = 25 DGS < 40 DGS < 70 DGS. Increasing dietary DGS did not increase E or N concentration in the feces but did significantly increase P which could increase the number of acres required to land apply the manure.

Key Words: distillers grains, fecal, phosphorous, *E.coli*

323 Effects of forage type and inclusion level of dried distillers grains plus solubles on feedlot cattle performance and carcass characteristics. R. L. Burgett,* D. M. Schaefer, and A. E. Radunz, University of Wisconsin, Madison.

Crossbred beef steers (n = 72, avg. BW = 345.5 \pm 40.7 kg) were used to evaluate the effects of forage type and inclusion level of dried distillers grains plus solubles (DDGS) on feedlot performance and carcass characteristics. Steers were blocked by initial BW into 3 groups (light, medium, and heavy) and randomly assigned to pens (n = 12). The experimental design was a 2 \times 2 factorial arrangement of treatments. Factors were inclusion level of DDGS (20% vs. 40%) and type of forage (corn silage = CS vs. hay = HAY) in beef cattle finishing diets. Experimental diets (on DM basis) were 20% DDGS plus 7.5% chopped hay (20HAY); 20% DDGS plus 15% CS (20CS); 40% DDGS plus 7.5% chopped hay (40HAY); and 40% DDGS plus 15% CS (40CS) and the remainder of the diets consisted of cracked corn and 15% vitamin-mineral supplement. Cattle were slaughtered by block at an average 12th rib fat thickness (1.0 cm). No interactions ($P = 0.65$) were detected between forage type and inclusion level of DDGS on feedlot performance. Initial and final BW was similar ($P \geq 0.29$) among treatments. Among forage types, steers fed CS had greater ($P = 0.003$) DMI than steers fed HAY, whereas DMI was similar ($P = 0.34$) between DDGS levels. Among treatments, ADG was similar ($P \geq 0.26$). Steers fed HAY had a greater ($P < 0.0001$) G:F than steers fed CS and steers fed 40% DDGS had a greater ($P = 0.04$) G:F than steers fed 20% DDGS. No interactions ($P = 0.48$) were observed for carcass characteristics, except for marbling score ($P = 0.04$). Steers fed 20HAY and 40CS had lower ($P < 0.05$) marbling scores than steers fed 40HAY, but 20CS did not differ ($P > 0.05$) in marbling score with the other treatments. Among treatments, there was no effect ($P \geq 0.29$) on BF, HCW, LM area, or USDA yield grade. Feed efficiency was improved for steers fed 40 vs 20% inclusion of DDGS and for steers fed chopped hay vs corn silage in feedlot finishing diets, whereas DDGS inclusion level and fiber type did not affect carcass cutability characteristics.

Key Words: DDGS, forage type, feedlot performance

324 Economic and feedlot responses to the addition of current technologies in yearling cattle. M. R. Schaefer,* A. E. Radunz, and D. M. Schaefer, *University of Wisconsin, Madison.*

Effects of modern efficiency enhancement technologies were assessed in yearling beef steers. Two trials were conducted with a replicated design consisting of 2 treatments: control (CON) or technology (TECH). Predominantly black-hided, pre-conditioned, non-implanted, yearling steers were blocked by initial BW (367.01 ± 16.3 kg) in Trial 1 ($n = 60$) and initial ultrasound 12th rib fat thickness (0.36 ± 0.16 cm) in Trial 2 ($n = 72$), then randomly assigned within block to pen. All steers received the same vaccinations, but TECH steers were dewormed with fenbendazole, implanted on d 21, and fed ractopamine for 26 d before harvest. The basal diet (NEg = 1.37 Mcal/kg, CP = 13.7%) contained (DM basis) 8% corn silage, 8% alfalfa silage, 17% dried distillers grain, 64% cracked corn, and 3% mineral-vitamin supplement. Steers fed CON were fed plus 0.40 kg/hd/day wheat middlings (DM), whereas TECH cattle received monensin (250 mg/d) and tylosin (80 mg/d) in wheat midd carrier. Cattle were slaughtered by block when 12th rib back fat thickness was estimated to be 1 cm. Days on feed for the blocks were 123 and 137 d (Trial 1) and 89 and 103 d (Trial 2) for early and late blocks, respectively. In both trials, TECH steers had greater ADG ($P \leq 0.002$), final BW ($P \leq 0.001$), and G:F ($P \leq 0.0001$). In Trial 2, TECH steers had greater ($P = 0.05$) DMI. In both trials, TECH steers had greater HCW ($P \leq 0.001$), whereas in Trial 2 LM area was greater ($P = 0.004$) for TECH steers. Treatment effects in 12th rib backfat thickness, KPH, and USDA yield grade were not detected ($P \geq 0.22$). In Trial 2, CON steers tended ($P = 0.09$) to have a greater marbling score. Economic analysis showed that TECH decreased total cost of gain ($P \leq 0.0003$) in both trials, and increased carcass value gained per DOF in Trial 2 ($P \leq 0.0001$), and in Trial 1 ($P = 0.10$). Net return was improved ($P = 0.002$) by TECH in Trial 2. Results indicate that feedlot cattle technologies improved steer growth efficiency and carcass weight.

Key Words: feedlot, economics, management

325 Supplementing the diets of early lactation Holstein dairy cows with ground field peas. J. Schroeder,* *North Dakota State University, Fargo.*

Thirty multiparous Holstein cows averaging 631 ± 9 kg BW and 71 ± 7 d in lactation were stratified by parity and milk yield to evaluate the effects of feeding dry field peas on yield and composition of milk. Cows were assigned to 1 of 3 treatments: 0 (control), 6.8, or 13.6% of ration DM as field peas in a randomized complete block designed experiment. Diets were formulated for 17.5% CP, 0.74 Mcal NEI per kg of DM, 64 to 36 ratio of forage to concentrate, and similar dietary rumen degradable protein, lysine, and methionine concentrations. Rations were composed of corn silage, alfalfa haylage and hay, beet pulp, dried distiller's grains plus solubles, soybean meal, rolled flax, corn gluten meal, blood meal, vitamins, and minerals. Treatments were adjusted for protein by proportionally reducing soybean and corn gluten meals and increasing blood meal, and for starch by reducing corn. Field peas were ground separately, mixed with concentrate, added to the forage, and delivered as a total mixed ration. Fresh water was always available. Diets were mixed daily and delivered once (0700) to ensure 5 to 10% refusal on an as-fed basis. Cows were milked twice daily and milk samples collected at the onset and every 2 weeks for 6 wk. Experimental and husbandry protocols were approved by the university animal care and use committee and cows were housed at the University Dairy Research and Teaching Center. The inclusion of

ground field peas did not alter ($P \geq 0.50$) DMI or body condition score ($P \geq 0.94$) of cows, but increased ($P \leq 0.04$) weight gained during the experimental period. Dairy cow lactation diets supplemented with 6.8 and 13.6% of DM as field peas resulted in similar ($P \geq 0.59$) production of actual and adjusted milk yields, and milk composition. No differences were noted for measures of individual or total ruminal VFA. Properly balanced diets for early lactation dairy cows can replace conventional protein and starch sources with up to 13.6% of ration DM as ground field peas and maintain cow health, milk yield, milk composition, and DM intake.

Key Words: field peas, ruminant, milk composition, byproducts

326 Frequency of TMR delivery and feeding behavior of individually fed early-lactation cows. A. Nikkiah* and S. M. Karimzadeh, *University of Zanjan, Zanjan, Iran.*

The mystifying animal response to feeding frequency (FF) reflects exclusivities of animal, dietary and housing conditions. As such, practice may never mirror theory. The objective was to determine FF effects on feeding behavior of early lactation cows. Eight multiparous Holsteins (577.5 kg BW, 33.0 kg milk yield) housed in free individual boxes (4×3 m) received either once ($1 \times$) at 0700 h or 2) 4 times ($4 \times$) at 0100, 0700, 1300 and 1900 h a TMR. The TMR had 62% concentrate. To minimize particle selection, water was spread onto the ration. The prepared TMR had 81% DM, 17.6% CP, and 27.3% NDF. The experiment had a 2×2 crossover design with 2 periods of 20 d, each with 14 adaptation days. Times spent eating, ruminating, standing, and laying were recorded visually for 24-h periods, and every 5 min, assuming that each activity would persist for the entire 5 min unless noticed otherwise. Data were analyzed as a linear mixed model with treatment fixed effect and cow plus period random effects. Once instead of $4 \times$ feeding increased ($P < 0.05$) intakes of DM (21.1 vs. 20.0 kg/d), NEL (36.4 vs. 34.3 Mcal/d) and NDF (5.8 vs. 5.5 kg/d) respectively. Orts as a percentage of the TMR fed were similar between $1 \times$ and $4 \times$, respectively (7.6 vs. 10%, $P = 0.24$). Daily duration of eating (323 vs. 284 min/d, $P = 0.49$), ruminating (302 vs. 326 min/d, $P = 0.66$), total chewing (624 vs. 609 min/d, $P = 0.37$), laying (537 vs. 586 min/d, $P = 0.40$), and standing (691 vs. 640 min/d, $P = 0.50$) were not different for $1 \times$ vs. $4 \times$ cows, respectively. The first meal length, starting from feed delivery until the first non-eating bout of ≥ 20 min, was 106 min in the $1 \times$ cows and totally 196 min in the $4 \times$ cows ($P < 0.01$). Hence, the adjusted first meal length was $196/4$ or 49 min i.e., $<$ half of 106 min in the $1 \times$ cows. The $1 \times$ feeding elongated the first meal by $>100\%$, supporting the greater DMI. The feed bunk presence without eating was longer ($P < 0.01$) in the $1 \times$ cows (39 min/d) than in the $4 \times$ cows (3.1 min/d). Results demonstrate that under uncompetitive individual housing, more frequent feeding shortened cow feed bunk presence and the average first meal, reduced daily energy and fiber intakes, and did not affect daily eating, ruminating and chewing duration of early lactation cows.

Key Words: feeding frequency, behavior, chewing, meal length

327 Ground wheat grain major inclusion in dairy diets: Challenging a conventional wisdom. A. Nikkiah,* F. Amiri, and H. Amanlou, *University of Zanjan, Zanjan, Iran.*

For its rapid fermentation and enormous use by humans, ground wheat grain (GW) has traditionally been overlooked in dairy rations and viewed as a risk to feed intake and rumen health. The objective was to

determine effects of GW level, particle size (PS) and their interaction on feed intake, peripheral blood metabolites, total tract apparent fiber digestibility, body weight and condition score changes, and milk production. Eight mid-lactation cows (176 ± 8 d in milk; mean \pm SE) were used in a 4×4 replicated Latin square design study with 4 21-d periods. Treatments were feeding either 20% or 10% of either finely or coarsely GW. Alfalfa hay based total mixed rations with forage to concentrate ratio of 47.5:52.5 were offered individually at 0900, 1600 and 2300 h. Data were analyzed as a linear mixed model with fixed effects of GW inclusion rate, coarseness, and the interaction plus random effects of cow and period. Ground wheat grain at 10% vs. 20% of diet DM tended to decrease blood BHBA (0.64 vs. 0.54 mmol/L), increased blood total proteins (8.28 vs. 8.46), and tended to increase blood albumin (3.72 vs. 3.83) concentrations. Dry matter intake increased (19.9 vs. 19.4 kg/d) when GW replaced half of dietary barley grain (i.e., 10% GW). Milk NEL yield and milk NEL to NEL intake ratio, milk solids content and yield as well as urine pH were unaffected by treatments. Fecal pH tended to increase (6.9 vs. 6.7) by increasing GW from 10% to 20% of diet DM. Total tract apparent DM digestibility was greater for coarser than for finer wheat grains (70% vs. 65%). Changes in body weight and body condition score were not affected. Findings provide novel data on the feasibility of feeding GW to mid-lactation cows on alfalfa hay based total mixed rations.

Key Words: wheat, starch, rumen, dairy cow

328 Mixed or organic vs inorganic forms of selenium (Se) differentially affect tissue Se concentrations of growing beef heifers. J. C. Matthews¹, D. C. Mahan², K. M. Brennan³, S. F. Liao¹, W. R. Burris¹, and J. A. Boling¹, ¹University of Kentucky, Lexington, ²The Ohio State University, Columbus, ³Alltech Inc., Nicholasville, KY.

The objective of this study was to determine if form of dietary Se supplement (TRT) affects Se content of different tissue types (epithelia: scraped duodenal, jejunal, and ileal; kidney; liver; pancreas; lung; 12th rib fat (RF); muscle: heart, longissimus dorsi (LD), semitendinosus (ST); uterus: left and right horns) of maturing beef heifers. Angus-cross heifers (BW = 398 ± 9 kg) were assigned (n = 10; stratified by initial liver Se concentrations) to 4 Se TRT and individually fed a basal diet (corn and cotton seed hull) to achieve an ADG of 0.5 kg/d for 224 d. Subsequently, heifers remained on TRT until killed over a 6-wk period (4/d, 1/TRT). The basal diet supplied 0.08 mg Se/d, whereas the mineral supplements provided no (control, C), or 3 mg Se/d as inorganic (sodium selenite, ISe), organic (SEL-PLEX, OSe), or a 50:50 mix (IOSe). Data were analyzed by one-way ANOVA using the GLM procedure of SAS. If the main effect (tissue; TRT) was significant, the least squares means were separated ($\alpha < 0.05$) using the pdiff option. Within a TRT, Se content ($\mu\text{g}/\text{mg}$) differed ($P < 0.0001$) across tissues, with tissues displaying similar patterns including the highest Se concentration in kidney (1.34 to 1.44) and the lowest in RF (0.028 to 0.042). Within a tissue, all 3 Se TRT increased ($P < 0.01$) Se content relative to C, except for kidney and RF for which no Se TRT effect was found ($P > 0.13$) and the pancreas for which ISe had no effect (P

= 0.21) but OSe and IOSe equally ($P = 0.002$) increased Se content. More specifically, OSe and IOSe TRT resulted in more ($P < 0.05$) Se accumulation than did the ISe TRT, except for ileal epithelium (ISe = OSe = IOSe; $P > 0.42$) and lung (IOSe > ISe = OSe, $P < 0.01$). In conclusion, supplementing Se at 3 mg/d in an organic form or 50:50 inorganic:organic mix results in more Se accumulation than in inorganic form for most tissues.

Key Words: cows, selenium supplementation

329 Relationship between polymorphisms in the prolactin promoter and cytochrome P450 genes, and feedlot performance by steers weaned from wild-type or non-toxic endophyte-infected tall fescue pastures. M. Ata^{*1}, K. P. Coffey¹, J. D. Caldwell¹, E. B. Kegley¹, M. L. Looper¹, A. N. Young¹, D. Philipp¹, D. S. Hubbell, III¹, and C. F. Rosenkrans, Jr¹, ¹University of Arkansas, Fayetteville, ²USDA-ARS, Booneville, AR.

Fescue toxicosis causes a reduction in performance that may persist for extended periods beyond tall fescue exposure. Specific genes may interact with tall fescue toxicosis to affect growth and carcass traits. The objective of this study was to determine the relationship among single nucleotide polymorphism (SNP) in prolactin promoter and cytochrome P450 genes with feedlot performance by steers weaned from toxic wild type (E+) or non-toxic (NE+) endophyte-infected tall fescue. A total of 81 spring or fall-born Gelvieh x Angus steers (230 ± 32.6 kg) were weaned from systems where they grazed either E+ (S100 and F100, respectively), or E+ for much of the year, but grazed NE+ for 1 mo before weaning (S75 and F75, respectively). Additional spring-born steers grazed NE+ continuously (SNE100) before weaning. Genomic DNA was collected from white blood cells. Restriction fragment length polymorphism (RFLP) using Xba I and Alu I restriction enzymes were used to determine the genotypes. Genotypes were homozygous cytosine (CC for both genes), homozygous thymine and guanine (TT for prolactin promoter, and GG for cytochrome P450, respectively), and heterozygous (CT for prolactin promoter, and CG for cytochrome P450 gene). Ribfat was affected ($P < 0.05$) by the interaction of prolactin SNP and forage treatments and was greatest for steers that were CC and weaned from S75. Steers with CC prolactin genotype had the lowest yield grade when compared with other genotype and forage combinations. Longissimus area was greater ($P < 0.05$) for steers with TT genotype and weaned from SNE100 than other groups. Marbling was affected ($P < 0.05$) by the main effects and interactions of cytochrome P450 genotype and forage treatments. Steers with CC genotype weaned from SNE100 had the greatest marbling score. Therefore, the combination of pre-weaning grazing strategies and identification of specific SNP genotypes may impact carcass measurements. This project was supported in part by the National Research Initiative of the National Institute of Food and Agriculture, USDA, grant # 2006-55618-17114, and specific cooperative agreements between Uof A Division of Agriculture and USDA-ARS.

Key Words: fescue, feedlot performance, single nucleotide polymorphism, steers

SYMPOSIA AND ORAL SESSIONS

Ruminant Nutrition II

330 Effects of lactobacillus acidophilus and yucca schidigera on finishing performance and carcass traits of feedlot cattle. C. A. Nichols^{*1}, K. H. Jenkins², J. T. Vasconcelos², G. E. Erickson¹, S. A. Furman², and S. R. Goodall³, ¹University of Nebraska, Lincoln, ²University of Nebraska Panhandle Research and Extension Center, Scottsbluff, ³Microbial Technologies, Omaha, NE.

A finishing trial evaluated effects of feeding a direct-fed microbial product (NovaCell) and a saponin feed additive (RumaJust) as a 2x2 factorial in steam flaked corn based diets containing 11% wet distillers grains (DM basis). No interaction was observed between NovaCell and RumaJust ($P > 0.13$). NovaCell did not impact ($P = 0.20$) finishing performance characteristics (final BW, ADG, DMI, and G:F) compared with cattle that did not receive NovaCell. The inclusion of NovaCell in finishing diets did not improve G:F ($P = 0.30$; 0.152 and 0.152) or ADG ($P = 0.96$; 1.67 and 1.65 kg/d) compared with cattle that did not receive NovaCell. Finishing performance data calculated on a live basis also indicated no effect ($P = 0.52$) of NovaCell on finishing performance (final BW, ADG, and G:F). Although NovaCell had no effect on ($P = 0.27$) 12th rib fat or YG, LM Area tended ($P = 0.10$) to be greater compared with cattle that did not receive NovaCell. NovaCell also did not impact HCW ($P = 0.86$; NovaCell 391 ± 10 kg vs. No NovaCell 389 ± 9 kg). RumaJust did not impact ($P = 0.24$) finishing performance characteristics (final BW, ADG, DMI, and G:F) compared with cattle that did not receive RumaJust. Finishing performance data calculated on a live basis also yielded no differences ($P = 0.92$) for finishing performance (final BW, ADG, and G:F) comparing RumaJust cattle to steers not fed RumaJust. Cattle fed diets containing RumaJust tended to have greater dressing percentages ($P = 0.06$) compared with cattle that did not receive RumaJust. RumaJust had no impact ($P = 0.21$) on HCW, fat depth, or LM area, however marbling was increased ($P = 0.03$) compared with cattle not fed RumaJust. Steers fed RumaJust had 43% more ($P = 0.05$) abscessed livers than cattle not fed RumaJust. Data indicate that RumaJust and NovaCell did not significantly impact finishing performance. However, RumaJust appeared to increase marbling and tended to increase dressing percentage.

Key Words: beef cattle, DFM, saponin

331 Vitamin D₃ effect on performance and meat tenderness in steers fed zilpaterol hydrochloride. K. T. Korn,^{*} M. C. Claeys, R. P. Lemenager, and J. P. Schoonmaker, *Purdue University, West Lafayette, IN.*

Two hundred 10 Angus x Simmental steers (init. BW 314 ± 11 kg) were allotted by BW to a 3 X 2 factorial arrangement of 6 treatments (5 pens per treatment; 3 heavy, 2 light blocks) to determine the effect of supplemental vitamin D₃ (0 IU [none], 250,000 IU for 165 d [long-term D], or 5 X 10⁶ IU for 10 d [short-term D]) on performance and meat tenderness in steers fed 0 or 8.38 mg/kg zilpaterol hydrochloride (Zilmax[®]) daily for 21 d. Steers were implanted with Revalor XS and

fed a growing phase diet (30% corn silage, 20% distillers grains, 1150 IU/kg vitamin D) for 54 d. Finishing phase diets (15% corn silage, 20% distillers grains, 750 IU/kg vitamin D) were fed for 114 d. Zilmax[®] or placebo was added to the diet 24 d and short-term D was added 13 d before slaughter. Treatments were removed from all diets 3 d before slaughter. Longissimus muscles were collected, cut into 2.54 cm thick steaks, and aged for 7, 14, or 21 d for Warner-Bratzler Shear Force (WBSF) determination. Short-term vitamin D decreased ($P < 0.03$) final BW, fat thickness, and longissimus muscle area compared with none or long-term vitamin D. Dressing percent did not differ among vitamin D treatments, but short-term D did decrease carcass weight compared with long-term D ($P < 0.02$). Zilmax[®] did not increase carcass weights in steers not fed supplemental vitamin D, but increased carcass weights 14.5 and 20.3 kg in steers fed long and short-term vitamin D (interaction, $P < 0.01$) and increased dressing percent for all vitamin D treatments ($P < 0.01$). Zilmax[®] increased longissimus muscle area and decreased fat thickness and marbling ($P < 0.03$). WBSF values were higher for Zilmax[®] steaks than non Zilmax[®] steaks at all aging periods ($P < 0.01$). Vitamin D did not improve tenderness and long-term D actually increased WBSF in steaks aged 21 d. In conclusion, Zilmax[®] leads to higher final BW and hot carcass weight, but vitamin D does not improve tenderness in steers given Zilmax[®].

Key Words: beef, vitamin D, Zilpaterol hydrochloride

332 Effects of haylage and monensin on performance, mineral status, and carcass characteristics of feedlot cattle fed diets containing 60% DDGS. T. L. Felix^{*} and S. C. Loerch, *The Ohio State University, Wooster.*

High grain prices may justify increased percentages of dried distillers grains with solubles (DDGS) in feedlot diets. The effects of forage level and monensin on feedlot cattle performance has not been investigated in high DDGS-based diets. Therefore, the objective of this research was to examine the interaction of monensin (0 or 33 mg Rumensin/kg diet DM) and haylage (0 or 10% of the diet DM) on the mineral status, performance, and carcass characteristics of feedlot steers. Angus-cross steers (n = 168; BW = 277 ± 67 kg) were blocked by weight and allotted in a 2 × 2 factorial arrangement of treatments to 24 pens. Dietary treatments were: 1) 0 mg monensin/kg diet and 0% haylage inclusion, 2) 33 mg monensin/kg diet and 0% haylage inclusion, 3) 0 mg monensin/kg diet and 10% haylage inclusion, and 4) 33 mg monensin/kg diet and 10% haylage inclusion. The remainder of the diet was 60% DDGS, 10% corn silage, 15% supplement and corn (either 5 or 15%) on a DM basis. Pens were slaughtered when the entire block was deemed finished so that the average days on feed for each treatment was the same (159 d). An interaction was observed for final BW ($P < 0.01$) and ADG ($P < 0.01$). When supplemented with 0 mg monensin/kg diet, added haylage increased ADG by 5.7%, whereas, when supplemented with 33 mg monensin/kg diet, added haylage increased ADG by 13%. There were no interactions of monensin and haylage for DMI or feed

efficiency ($P \geq 0.36$). Haylage inclusion increased ($P < 0.01$) DMI and decreased ($P < 0.01$) feed efficiency. There were no interactions on plasma mineral concentrations; however, over time, ceruloplasmin and plasma Cu concentration were decreased ($P < 0.01$), whereas, plasma S concentrations increased ($P < 0.01$), regardless of dietary treatment. There were no differences ($P \geq 0.06$) in liver mineral concentrations. There were no interactions ($P \geq 0.08$) on carcass characteristics. Cattle fed 60% DDGS diets benefited from increased dietary forage and the effects of monensin and forage were additive for ADG and HCW.

Key Words: dried distillers grains, feedlot cattle, minerals, monensin

333 Relationship of gain and quality grade to feedlot profitability. S. T. Walter*¹, R. L. Hale¹, and L. R. Corah², ¹Professional Cattle Consultants, Weatherford, OK, ²Certified Angus Beef LLC, Wooster, OH.

To analyze the impact of feedlot performance and carcass characteristics on cattle feeding profitability, data on 443,129 steers in 4,413 lots was compiled by Professional Cattle Consultants from 2004 to 2009. Data were analyzed and classified into Low, Middle and High profit groups based on net per head profitability for the lot; as well as Low, Middle and High quality grade groups based on percentage Choice or higher criteria. NHTC and naturally fed cattle were excluded from the data set. For analysis purposes, cost-in-price was standardized by assigning a feeder cattle price index with a 5 cent slide applied either way from 341 kg. Actual selling price, on a carcass basis, was used in the analysis. All feedlots used traditional high concentrate rations that ranged from \$166/ton in the early years to \$318/ton in 2008. Finished weight, YG 1 and 2, YG 4 and 5 and profit/loss all differ (<0.01). Calculated profit from Low to High profit groups varied by \$129.41/head. High profit groups gained an additional 0.23 kg/day more than Low profit groups, while having 6.4 percent more Choice or higher carcasses and 2.9 percent more Premium Choice or higher carcasses. Cattle classified in the High quality grade category gained faster, had heavier carcasses and double the calculated profit. The most profitable feedlot cattle have higher rate of gain, heavier carcasses and higher quality grades in spite of having higher yield grade 4 and 5 percentages.

Table 1.

	Profit Profile			Quality Grade Profile		
	Low	Middle	High	Low	Middle	High
Placement Wt, kg	335	331	327	331	332	329
Finish Wt Live, kg	577	586	596	580	587	593
ADG, kg	1.27 ^a	1.42 ^b	1.50 ^c	1.35 ^a	1.40 ^b	1.45 ^c
HCW, kg	369 ^a	376 ^b	381 ^c	372 ^a	375 ^b	378 ^c
% Choice or Higher	49.8 ^a	51.7 ^b	56.2 ^c	33.3 ^a	51.9 ^b	72.8 ^c
% CAB [®] or Upper 2/3						
Choice Premium	9.6 ^a	10.9 ^b	12.3 ^c	5.0 ^a	9.9 ^b	18.0 ^c
% YG 1&2	51.8	51.5	46.5			
% YG 4&5	11.0	12.1	13.0			
Calculated Profit/Loss, \$/hd	-39.15	27.90	90.26	18.03	24.02	35.21

^{a,b,c}Figures with superscripts are statistically different by <0.01 .

Key Words: feedlot profits, growth, quality grade

334 (Invited ASAS Animal Science Young Scholar) Developmental programming and the ruminant small intestine: Responses of the dam and offspring to alterations in gestational nutrition. A. M. Meyer*¹, K. A. Vonnahme¹, D. A. Redmer¹, L. P. Reynolds¹, B. W. Hess², and J. S. Caton¹, ¹North Dakota State University, Center for Nutrition and Pregnancy, Department of Animal Sciences, Fargo, ²University of Wyoming, Department of Animal Science, Laramie.

Small intestinal development, vascularization, and function are critical for optimal animal growth and performance, playing a major role in nutrient digestion and absorption, energy and nutrient expenditure, and immunological competence. The small intestine is known to change with intake and physiological state; however, its relationship with developmental programming remains unclear. Three experiments investigated effects of gestational nutrition on small intestinal growth and vascularization of the dam and offspring. In Experiment 1, effects of stage of gestation and maternal nutrient restriction during early to mid-gestation were determined for mature beef cows and their offspring. The maternal intestine was minimally responsive to nutrient restriction, but effects of advancing gestation on the intestine give insight into possible alterations to meet demands of fetal growth. In addition, fetal intestinal responses to nutrient restriction suggest increased efficiency or compensatory growth potential of offspring. In Experiment 2, effects of nutritional plane and Se supply during gestation on primiparous ewes and their lambs were investigated. The maternal (parturition and d 20 of lactation) and neonatal lamb (20 d of age) intestine were both impacted by nutritional plane and, to a lesser extent, Se supply during gestation. Intestinal growth, vascularity, and angiogenic factor mRNA expression were altered in the dam and offspring, suggesting that effects of gestational nutrition extend to early lactation and neonatal life. In Experiment 3, effects of nutrient restriction and ruminally undegradable protein supplementation during early to mid-gestation on beef cows were studied. Resulting intestinal tissues from market-weight steers and heifers appear to have corrected for gestational nutritional insults, although future research may help to explain observed offspring performance. Better understanding of effects of gestational nutrition on the maternal and offspring intestine will allow for development of management and therapeutic strategies to optimize performance.

Key Words: developmental programming, gestational nutrition, intestine, ruminant

335 Influence of maternal high intake, estrogen replacement, and intrauterine growth restriction (IUGR) on fetal intestinal mass and vascularity. R. D. Yunusova*¹, R. P. Aitken², J. M. Milne², A. M. Meyer¹, P. P. Borowicz¹, A. T. Grazul-Bilska¹, L. P. Reynolds¹, D. A. Redmer¹, J. S. Caton¹, and J. M. Wallace², ¹North Dakota State University, Department of Animal Sciences, Fargo, ²Rowett Institute of Nutrition and Health, University of Aberdeen, Aberdeen, Scotland, United Kingdom.

Objectives were to investigate the effects of excess maternal intake, IUGR, and 17 β -estradiol (E2) replacement therapy during mid-gestation on fetal gastrointestinal mass and vascularity. Singleton pregnancies (single sire) were established by embryo transfer, and then adolescent dams were offered a control diet (C, n = 12), fed 100% estimated ME and CP requirements or a high diet (H, n = 26), fed approximately twice the dietary intake of C treatments. From d 50 to 90, i.m. injections of E2 (0.05 mg) were given twice daily to 12 ewes fed H diets (H + E2 treatment). Ewes were fed twice daily and housed individually indoors. At necropsy at d 130, fetal organ masses were

measured and jejunal tissues harvested. Ewes in H and H + E2 treatments having fetuses $\leq 3,550$ g at d 130 were designated as H IUGR (n = 8) and H + E2 IUGR (n = 5) groups, respectively. Data were analyzed for effects of E2 replacement, excess maternal intake, and IUGR. Excess maternal intake decreased ($P \leq 0.001$) fetal body weight and other organ masses. However, within IUGR groups the presence of E2 restored ($P = 0.02$) total small intestinal length. Collected jejunal tissues were perfusion fixed with Carnoy's solution, paraffin embedded, and vascular structures were visualized microscopically. Total small intestinal vascularity was decreased ($P = 0.005$) due to IUGR. The H + E2 IUGR fetuses had less ($P = 0.08$) jejunal capillary area density (30.9 vs. $24.6 \pm 2.76\%$, respectively) and less ($P = 0.09$) capillary surface density (1.15 vs. $0.98 \pm 0.08 \mu\text{m}/\mu\text{m}^2 \times 10$, respectively) compared with H IUGR without E2 fetuses. Additionally, in both offspring from H treated ewes and those that were IUGR, maternal E2 increased [$(P = 0.05)$ and $(P = 0.004)$, respectively] jejunal GUCY1B3 relative mRNA expression. In conclusion, maternal high nutritional plane and E2 therapy during mid-gestation resulted in some changes in offspring intestinal vascularity, mRNA gene expression, and small intestinal length. Additional work is needed to investigate E2 impacts on intestinal function and nutrient uptake.

Key Words: intestine, maternal nutrition, 17β -estradiol

336 (Invited ADSA Young Dairy Scholar) Metabolic and inflammation indexes, blood neutrophil function, and gene expression profiles in transition dairy cows in response to prepartal dietary energy level and early postpartal mammary *E. coli* lipopolysaccharide challenge. D. E. Graugnard^{*1}, M. Bionaz¹, E. Trevisi², S. L. Rodriguez-Zas¹, R. E. Everts¹, H. A. Lewin¹, J. K. Drackley¹, G. Bertoni², and J. J. Looor¹, ¹University of Illinois, Urbana, ²Universita Cattolica del Sacro Cuore, Piacenza, Italy.

The periparturient period in dairy cows is associated with peak incidence of production and infectious diseases. We hypothesized that plane of

dietary energy pre-parturient can affect the response to inflammatory challenges through changes in neutrophil function, metabolic indexes, and gene expression. Twenty Holstein cows were fed diets to meet (control diet, 1.34 Mcal/kg DM) or exceed (overfed diet, 1.62 Mcal/kg DM; providing ~159% of energy requirements) dietary energy requirements during the entire dry period (~45 d). In addition, at 7 d post-calving cows received an intra-mammary bacterial lipopolysaccharide (LPS) challenge (200 μg) into one rear mammary quarter to evaluate the effect of inflammation post-parturient. Blood was collected to assess metabolites, inflammation markers, and neutrophil chemotaxis and phagocytosis. Biopsies of liver and mammary tissue were collected to measure mRNA profiles using a 13,257 bovine oligonucleotide microarray. Further, lipid and triglyceride (TAG) concentrations were measured in liver tissue. There were no differences in milk yield among groups through 40 DIM. During the same period of time, dry matter intake (% of BW) was higher for the control group (Diet $P < 0.05$). NEFA concentrations were significantly higher in overfed cows at 10–14 DIM (Diet x Time $P < 0.05$). Liver lipid and TAG concentration had the same response as NEFA. Reactive oxygen metabolites also were higher in the overfed group (Diet $P < 0.05$). Phagocytosis capacity was higher in the control group at 14 DIM (Diet x Time $P < 0.05$). The mammary gland was responsive to the intra-mammary challenge with more than 800 genes (DEG) being affected, although the response was minor with pre-parturient diet (15 DEG). Liver tissue had a marked response to the intra-mammary challenge (650 DEG) and pre-parturient diet (750 DEG). The main biological processes enriched within the DEG, were phagocytosis, apoptosis, inflammatory response, and response to LPS. Overall, results suggest that overfeeding energy during the dry period may render dairy cows more vulnerable to infectious diseases as well as metabolic disorders during early lactation.

Key Words: dairy cow, inflammation, phagocytosis, transcriptomics

Monday, March 14, 2011

SYMPOSIA AND ORAL SESSIONS

Teaching: Enhancement of Student Learning Using Activities Outside of the Classroom

337 (Invited) Research-based approaches to developing effective teaching skills. E. Offerdahl,* *North Dakota State University, Fargo.*

As members of the academy, we are trained to pose questions of the world around us, to gather data to answer those questions, and to be critical of the interpretations of those data. Yet many of us fail to employ these same skills to evaluate the effectiveness of our teaching. Rather, we more often rely on incomplete or anecdotal evidence to inform our decisions about the efficacy of our teaching. In contrast, teaching can be approached with the same critical thinking and spirit of experimentation that we employ in our research. In doing so, we can begin to advance our pedagogical knowledge and skills in support of students' deep conceptual development. In this presentation, methods for collecting and evaluating evidence of student learning will be discussed and how these data can be used to improve our teaching skills.

338 (Invited) Teaching techniques for enhancing the learning experience of today's students: Engaging Students. D. S. Buchanan,* *North Dakota State University, Fargo.*

For students to truly learn there must be a 3-point connection between the teacher, the student and the material. The flow of thought among

these 3 points must be continuous and multi-directional. This requires engaging the students in such a way that they make contributions to the learning that is taking place. In a time when a plethora of distractions confront our students, true engagement is sometimes difficult. The lives of students are constantly invaded with transitory input that can make serious investigation of ideas more difficult. On the other hand, when students find genuine relevance in the subject matter, they can absorb ideas more rapidly than the instructor can deliver. This creates a learning situation that is vital and in which it is difficult to differentiate between student and instructor in terms of who is teaching and who is learning. Like so much else in teaching, engagement of students is very dependent upon the personalities of the students and the instructor. As a result, any single method will not work in every situation. However, the goal of engagement is relatively constant. The student must see the relevance of the subject matter, will actively desire to learn more and needs to be able to see that the instructor desires a joint exploration of ideas. This presentation will discuss ways that professors of the animal sciences engage students for various types of subject matter and outline some of the advantages and disadvantages of various approaches.

POSTER PRESENTATIONS

Teaching

339 Successes and failures of outcome/assessment activities in animal sciences at Purdue University. M. A. Diekman,* Q. D. Ford, and M. E. Einstein, *Purdue University, West Lafayette, IN.*

To become reaccredited by the Higher Learning Commission in 2010 several activities were conducted in the Department of Animal Sciences to address outcome/assessment measures. At the curriculum level, Animal Sciences seniors responded to a rubric indicating which courses or experiences they felt met their definition of graduation attributes as defined by the college. For 113 seniors, 627 responses were obtained concerning 9 learning outcomes: professional preparation, scientific principles, critical thinking, communication, teamwork, cultural understanding, social science principles, civic responsibility and lifelong learning. Of these learning outcomes, the following activities were identified by students in achieving these outcomes: coursework (58.2%), internships (14.7%), clubs (7.9%), community service (7.1%), study abroad (5.9%), leadership opportunities (4.4%), and undergraduate research (1.8%). At the curriculum level, student opin-

ions on contemporary issues effecting animal industries (animal well-being, animals used for biomedical research, or impact of biofuels on animal production) were compared for Animal Sciences seniors ($n = 101$) and freshmen ($n = 127$). Scores obtained with a writing rubric were higher for seniors than freshmen on well-being issues (15.7 vs. 14.8, SEM = 0.2, $P = 0.016$) and biomedical research (16.1 vs. 15.0, SEM = 0.3, $P = 0.011$) but similar on production of biofuels (16.5 vs. 15.5, SEM = 0.6, $P = 0.28$). In a junior level reproductive physiology course, pre and post questions were used to assess learning within a course. Correct answers to 12 multiple choice questions identifying hormones controlling reproduction were higher on the final exam than on the first day of class ($n = 60$, 9.2 vs. 4.3, SEM = 0.26, $P < 0.001$). In the above activities success was achieved when scores were increased but failures occurred when faculty participation was low or students did not put forth their best effort in assessment procedures.

Key Words: curriculum, learning outcomes, assessment

SYMPOSIA AND ORAL SESSIONS

Undergraduate Student Oral Competition

340 QTL mapping of coat color traits in an F2 Duroc x Pietrain pig resource population. C. Pike,* R. O. Bates, C. W. Ernst, J. P. Steibel, and D. B. Edwards, *Michigan State University, East Lansing.*

Many quantitative trait loci (QTL) in pigs linked to coat color, spotting, and hair density traits are also linked to skin disease and other abnormal skin conditions, such as melanoma and albinism. Despite its relevance as proxy traits for skin health traits, the genetic control of pig coat color and hair density has not been extensively studied. The objective of this study was to map QTL for coat color, hair density, and spotting traits in a pig resource population. To accomplish this, a genome scan was performed on 510 pigs from the Michigan State University Duroc x Pietrain F2 pig resource population using 124 microsatellite markers genotyped across the 18 autosomes with an average marker spacing of 24 cM. Pigs were digitally photographed and evaluated for coat color, spotting and hair density. A line cross model, and an epistasis analysis were performed in GridQTL (<http://www.gridqtl.org.uk/>) to find regions significant at a 5% genome-wide level. This resulted in 5 putative QTL regions on chromosomes 1 (2 regions), 6, 13, and 15. In addition, a potential epistatic interaction was observed between chromosomes 1 and 8 for spot size. On chromosome 1, 2 regions were identified at 180 cM ($F = 17.59$) for spot size, and at 122 cM ($F = 24.1$) for spot size and coat color. On chromosome 13, a region at 29 cM ($F = 13.83$) exhibited linkage to spot presence, and, on chromosome 15, hair density was linked to a QTL located at 70 cM ($F = 37.31$). On chromosome 6, a QTL at 7 cM ($F = 54.83$) was observed for spot size and spot presence. The MC1R gene, which has previously been studied regarding its effects on coat color, maps within this region of chromosome 6. Regions identified for epistatic interaction were on chromosome 1 at 122 cM, and chromosome 8 at 179 cM ($F_{int} = 4.55$). Future efforts will focus on investigation of association of these QTL with economically important traits and identify potential candidate genes within these QTL genes and explore potential applications of the pig as a model for human health.

Key Words: quantitative trait loci, pig, coat color

341 Effects of gestational energy source on feedlot performance, glucose tolerance, and carcass traits of progeny. L. M. Shoup*¹, T. L. Felix¹, A. E. Radunz², and S. C. Loerch¹, ¹The Ohio State University, Wooster, ²University of Wisconsin, Madison.

Effects of maternal energy source during gestation on postnatal growth and metabolism of progeny has not been well described. The objectives of this experiment were to determine the effects of hay (HAY), corn (CORN), or dried distillers grains (DDGS) fed to cows in late-gestation on progeny post-weaning growth, glucose tolerance, and carcass characteristics. Angus-cross cows ($n = 84$; BW = 620 ± 12 kg) were blocked by BW and allotted to 4 pens per treatment. Dietary treatments were fed at isocaloric intakes from 155 to 272 d of gestation. Following parturition, cows and calves were fed and managed as 1 group. Post-weaning, steers ($n = 27$) and heifers ($n = 27$) were transported to the feedlot, housed in individual pens, and fed a common diet which contained 50% cracked corn, 20% DDGS, 15% corn silage, and 15% supplement (DM basis). A glucose tolerance test (GTT) was

conducted on calves ($n = 12$) on d 41 and d 111 after feedlot arrival and blood samples ($n = 7$) from each calf were collected from 5 to 120 min post-glucose intravenous infusion (0.25 g of glucose/kg of BW). Calves were slaughtered at a 12th rib fat thickness of 1.2 ± 0.05 cm as determined via ultrasound. Gestational diet did not affect ($P \geq 0.30$) progeny feedlot performance (initial BW, final BW, DMI, ADG, or G:F). During the GTT, fasting concentration and area under the curve (AUC) for glucose and insulin were not affected ($P \geq 0.47$) by treatment. Glucose clearance rate was greater ($P = 0.01$) in progeny from dams fed CORN than progeny from dams fed HAY or DDGS. Initial insulin response was greatest to least ($P < 0.01$) for calves from cows fed CORN, DDGS, and HAY, respectively. Fasting insulin, insulin AUC, glucose AUC, and glucose clearance rate were all greater ($P < 0.01$) on d 111 than d 41. There were no differences ($P \geq 0.33$) among treatments for carcass characteristics. Gestational energy source did not affect feedlot performance or carcass traits; however, it did affect glucose clearance rate and initial insulin response. Days on feed increased insulin resistance and decreased glucose tolerance when cattle were fed a high-grain diet.

Key Words: gestational nutrition, beef cattle, glucose tolerance

342 Parturition supplementation of distillers grains to beef cows influences cow performance. A. R. Schroeder,* D. W. Shike, D. A. Faulkner, T. B. Wilson, and F. A. Ireland, *University of Illinois, Urbana.*

Angus cows ($n = 128$) and crossbred cows ($n = 132$) were utilized to evaluate the effects of parturition supplementation of dried distillers grains plus solubles (DDGS). Cows were blocked by breed, and each breed was randomly allotted into 6 groups. Half the cows were supplemented with 2.1 kg DM/head/d DDGS while the remainder of the cows did not receive any supplementation. The supplementation period was 60 d parturition until calving. Each pair of replicate groups were grazed on tall fescue and red clover mix pastures of similar size. To decrease variation between pastures, forage density and height samples were taken with a rising plate meter. Measurements were compared and only pastures of similar density and height were used. Initial cow body weights and BCS were recorded on all cows at initiation of supplementation period. No differences between initial body weight ($P = 0.79$) and initial BCS ($P = 0.22$) were found. Supplemented cows were fed daily until calving. Once weekly, cows that had calved were removed from test pastures, weighed, and assigned a BCS before being commingled in pastures without further supplementation. Calves were weighed at birth. No difference in calf birth weights ($P = 0.37$) were observed. Supplementation tended to increase cow body at calving ($P = 0.08$) and BCS change ($P = 0.09$). Supplemented cows had greater ADG ($P = 0.04$) over the feeding period when compared with cows with no supplementation. In agreement, cows also had a more positive weight change ($P = 0.04$). In summary, parturition supplementation of distillers grains to beef cows improved cow BW and ADG without causing a change in calf birth weights.

Key Words: distillers grains, beef cows, cow supplementation

343 Analytical and experimental procedure to select reference genes for qPCR normalization data. N. P. Taylor,* R. Manjarin, N. L. Trottier, J. Liesman, and J. P. Steibel, *Michigan State University, East Lansing.*

Variation of cellular activity in a tissue induces changes in RNA and DNA concentration between samples, which may affect the validity of mRNA abundance of target genes obtained with real-time PCR (qPCR) analysis. A common way of accounting for such variation consists of the use of a reference gene as a normalizer. Programs such as geNorm™ can be used to select for suitable reference genes, although a large set of candidate genes that are assumed to be not co-regulated needs to be analyzed to obtain accurate results. The objective of this study was to propose an analytical protocol to assess the invariance of reference genes in porcine mammary tissue using mammary RNA and DNA concentrations as correction factors. Mammary gland was biopsied from 4 sows on d 110 of gestation (pre-partum), on d 5 (early) and 17 (peak) of lactation, and on d 5 after weaning (post-weaning). Relative expression of potential reference genes API5, MRPL39, VAPB, ACTB, GAPDH, RPS23 and MTG1, and target gene SLC7A1 was quantified by qPCR using a relative standard curve. The response in gene expression to RNA and DNA as correction factors was tested using a linear mixed model fitting RNA and DNA concentration as regression variables. Results were compared with those obtained with geNorm™ analysis, and reference genes selected by each method were used to normalize SLC7A1. Relative mRNA abundance of API5, GAPDH and MRPL39 remained unchanged ($P > 0.1$) across stages after correcting with RNA and DNA concentration, whereas geNorm™ analysis selected MTG1, MRPL39 and VAPB as best reference genes. There were no differences between normalization of SLC7A1 with genes selected by the linear model or by geNorm™. In conclusion, the linear mixed model and geNorm™ selected different reference genes, but SLC7A1 fold changes did not differ when using genes obtained under either method. These results indicate that among the set of candidate genes, there is more than one suitable reference gene. The proposed method, however, has the strength of allowing testing each gene individually and sequentially, so analysis of remaining candidate genes can be spared as soon as a good reference gene is found.

Key Words: qPCR, reference, RNA, geNorm™

344 Effect of sire type on the value of market wethers for commercial farms. E. L. Pearson,* A. B. Culham, J. E. Link, and G. M. Hill, *Michigan State University, East Lansing.*

Today's livestock industry is faced with many challenges including finding ways to be more profitable. The objective of this study was to determine if terminal sire rams could increase the profitability of a commercial sheep operation that finished their lambs as well as provide information to lamb feedlot operators and lamb packing plants on differences in lamb sire types on slaughter lamb values. In this study, we compared crossbred wethers sired by a terminal sire, a Suffolk ram, with wethers sired by a maternal sire, a Polypay ram. Dams were moderate framed, crossbred, Dorset-based ewes. The wethers were weaned at 60 d of age and adjusted to a concentrate diet for 14 d. Terminal sired ($n = 11$) and maternal sired ($n = 11$) wethers were mixed, group housed in 2 pens, and fed a 15% crude protein diet of corn and a protein pellet. No hay was provided to allow for simulation of a feedlot scenario. Ultrasound data (LEA and fat thickness) were collected for each lamb and adjusted to a market weight of 61 kg. The percent of boneless closely trimmed retail cuts (BCTRC) was calculated using adjusted numbers and body wall thickness that was calculated from

fat thickness. Data were analyzed using Proc Mixed (SAS). Terminal sired wethers had a larger LEA (20.45 cm²) than wethers sired by the maternal sire ram (17.37 cm²; $P = 0.005$). The carcass value of the terminal sired wethers was \$4.57 more per 100 kg than the carcass value of maternal sired wethers ($P = 0.004$). On a live basis, the difference was \$2.29 more per 100 kg ($P = 0.004$). The 48.48% BCTRC of the terminal sire wethers was greater than the BCTRC of the maternal sired lambs (46.78%; $P = 0.004$). The 12th rib fat thickness of the terminal sired rams was 0.57 cm and less than the wethers sired by the maternal sire (0.67 cm; $P = 0.086$). In conclusion, a producer will increase profit by selling terminal breed sired lambs on a merit based system because of their higher live weight and carcass value.

Key Words: terminal sire, maternal sire, market lamb

345 Effects of temperature on behavior and feed intake of group housed ram lambs. M. D. van Benschoten,* A. B. Culham, J. E. Link, and G. M. Hill, *Michigan State University, E. Lansing.*

Producers monitor feed intake of their livestock daily to evaluate the health and growth of their animals. Limited information is available on daily feeding behavior patterns of ruminants. The objective of this study was to evaluate the effect of meal size and daily temperature on daily feed consumption. Purebred Suffolk ram lambs were weaned at approximately 60 d of age and adapted to a concentrate diet. At approximately 90 d of age and 47 kg, 23 Suffolk ram lambs started the 42-d trial. Rams were tagged with radio frequency tags (RFID) to be read by an electronic feeder, group housed in 2 separate pens, and individually fed via electronic feed monitoring system with feed intake recording equipment (FIRE). Ram weight and feed consumed per visit were recorded; data were analyzed using Proc Mixed (SAS) and linear correlations. The expected daily feed consumption (3.22% of average daily BW of the group) was compared with the average actual feed intake. On d 1, 13, 22, 27, 32, 36 of the study the consumption differed ($P < 0.05$). Significant increases in actual FI on d 13 and 22 were preceded by a drop in daily high temp of at least 5°C over the previous 2 d. Significant decreases in actual FI on d 27 and 32 were preceded by at least 4 d of daily high temperature of 26.7°C. Rams were categorized into growth groups based on their ADG with high ($n = 6$, ADG >0.66 kg), medium ($n = 11$, ADG between 0.55 and 0.65 kg), and low ($n = 6$, ADG >0.53 kg). The ADFI of the high rams was greater than the rams in the medium and low groups ($P = 0.002$). There was a negative correlation between total visits to the feeder and the feed consumed per visit (0.8819 and 0.8056 for high and medium gaining rams, respectively). Little is known about feed consumption patterns and ADG and G/F in sheep. However, we showed that the fastest gaining ram lambs do not eat more frequently, but consume more feed at each meal, and daily temperatures between 8.3 and 31.1°C did not consistently alter feed consumption patterns.

Key Words: ram lambs, temperature, feed intake

346 Effects of ivermectin on fescue toxicosis in first calf beef heifers. K. D. Vogelzang,* D. B. Faulkner, F. A. Ireland, and D. W. Shike, *University of Illinois, Urbana.*

Angus and Angus x Simmental heifers ($n = 40$) were randomly assigned to 2 treatments: 0.5% topical ivermectin® (Agrimectin; 1mL/10kg BW) at the start and on d 48 of the 78 d study, and not treated. All heifers were treated with Dectomax® to remove any parasite infestation before the start of the study. The heifers calved just before the start of

the study and were managed as a single group on endophyte infected fescue pasture for the entire study. Cow weights, calf weights, cow BCS (1–9 scale), and cow hair cost (1–5 scale) were measured at the beginning and end of the study. Milk production was measured using the weigh suckle weigh procedure at the end of the study. Body temperatures were measured every hour using an inter-ruminal temperature device. Mean temperatures and peak (highest 10 measurements) temperature were calculated for each animal. Final weights ($P = 0.71$), body condition score ($P = 0.74$) and the average daily gain ($P = 0.55$) of the control heifers was not different than the treated heifers. At the end of the study, the untreated heifers had a shorter-slicker coat while the ivermectin treated heifers had a rougher-longer coat (2.85 vs. 3.15, $P = 0.11$). The milk production in the untreated heifers was higher than the ivermectin treated group (23.1 L vs. 18.2 L, $P < 0.05$) which is reflected by the untreated group's tendency for higher calf ADG (0.541 kg vs. 0.482 kg, $P = 0.18$). No differences were observed for average or peak body temperatures ($P > 0.37$). Topical ivermectin decreased milk production, resulted in a rougher hair coat, and tended to decrease calf average daily gain in this study.

Key Words: ivermectin, fescue toxicosis

347 Effects of feeding steam-flaked corn, dry-rolled corn, and wet distillers grains plus solubles on variance in cattle intake. B. L. Sorensen,* A. K. Watson, C. A. Nichols, C. D. Buckner, K. H. Jenkins, T. J. Klopfenstein, and G. E. Erickson, *University of Nebraska, Lincoln.*

A finishing trial was conducted to determine the effects of feeding blends of steam-flaked corn (SFC) with dry-rolled corn (DRC) and the inclusion of wet distillers grains plus solubles (WDGS) on variation in DMI of finishing cattle which would be indicative of subacute acidosis. Cattle were fed corn based diets containing 0 or 35% WDGS (DM basis) that included ratios of SFC to DRC. Ratios were 0, 25, 50, 75, or 100% SFC in combination with dry-rolled corn (DRC; DM basis). Cattle were blocked into 3 weight blocks, 12 steers per pen, with 4 pens per treatment. Intakes were measured daily as a percent of initial body weight and the measurements were averaged by week across a 13 week period. Steam-flaked corn was measured at arrival to the feedlot (3 times per week) for bushel weight to determine whether there was a correlation between bushel weight (Avg = 0.41 kg/L; SD = 0.02 kg/L) and feed intake variation (Avg = 11.05 kg; SD = 0.45 kg). Intake variation was measured each day then averaged across that week for the 13 week period. There were only low correlation values between bushel weight and feed intake variation ($R^2 \leq 0.11$ for all treatments). No interaction occurred between DMI variation with level of WDGS and ratio of SFC to DRC ($P = 0.95$). However, when WDGS was included in the diet, the variance in feed intake decreased ($P \leq 0.01$). Considering variances across weeks, and SFC to DRC ratios, variability in intakes with WDGS containing diets was roughly half the variability with no WDGS in the diet. Therefore, we conclude that variation in bushel weight of SFC or inclusion level of SFC relative to DRC had no effect on variation in intake whether it was with or without WDGS. However, including WDGS in the diet decreased weekly variance in intake.

Key Words: intake variance, steam-flaked corn, wet distillers grains plus solubles

348 Effect of feeding high sulfur vs. high crude protein diets on heifer growth and performance. P. L. Steichen*¹, J. K. Grant², C. L. Wright², G. A. Perry², K. A. Vonnahme¹, and M. L. Bauer¹, ¹North

Dakota State University, Fargo, ²South Dakota State University, Brookings.

To determine the effects of high dietary S, high dietary N, or both on feed intake and heifer growth, heifers ($n = 25$; 328 ± 16 kg of BW) were assigned randomly to 1 of 4 dietary treatments: control (CON; approximately 13.4% CP and 0.17% S); high S (S; CON plus calcium sulfate to achieve 0.26% added dietary S); high N (N; CON plus a slow releasing urea in supplement and hay sprayed with urea to achieve 5.1% added dietary CP); or both high S and N (SN). The control diet was 67.2% grass hay, 20% soybean hulls, 4% cracked corn, 6% soybean meal, 1.6% calcium carbonate, 1% concentrated separator byproduct, and 0.2% trace-mineralized salt. Heifers were fed individually at 2.6% of BW and were acclimated to the CON diet 7 d before the start of the project. Orts were collected daily before feeding at 0700. Heifers were weighed daily at 1400. Seven days after dietary treatments began, heifers were synchronized to achieve a similar reproductive status. Mixed procedure of SAS was used to analyze repeated measures of intake and BW. Intake was not affected by treatment ($P \geq 0.32$) and was 9.46, 9.12, 9.57, 9.65 ± 0.51 kg/d for CON, S, N, and SN, respectively. Body weight gain was affected by S (day x S; $P = 0.07$), but not by N (day x N; $P = 0.38$), and S and N did not interact (day x S x N; $P = 0.85$). Final BW (346 ± 17 kg BW) were not different ($P \geq 0.79$) among treatments. Average daily gain responded quadratically for heifers fed S where they did not gain weight initially but rebounded to have similar weights to heifers not fed S. Sulfur appears to have negatively affected growth rate during the first week after feeding calcium sulfate, but heifers appeared to adjust to these high dietary concentrations. Dietary S may have had a detrimental effect because of ruminal hydrogen sulfide production, alteration in systemic acid-base status, or both; neither responses were measured. It appears high dietary S, in the form of calcium sulfate, has short-term detrimental effects on growth.

Key Words: gain, intake, nitrogen, sulfur

349 Effect of split-suckling and feeding coconut oil on piglet performance and survival. K. Gebhart*¹, D. Jensen², S. Kitt², J. Sonderman², and C. Hostetler¹, ¹South Dakota State University, Brookings, ²Danbred North America, Columbus, NE.

Adequate consumption of colostrum at birth enhances piglet growth and survival. However, the increasing litter size of the US swine herd has increased the competition for colostrum between pigs. The purpose of this experiment was to determine the effect of split suckling and feeding coconut oil to newborn pigs baby pig growth and survivability. Litters from a total of 384 sows were randomly allotted to one of 4 different treatments as follows. Piglets were allowed to split-suckle once (Trt1, $n = 890$), split-suckle twice (Trt 2, $n = 948$), split-suckle once with coconut oil (Trt 3, $n = 899$) or split-suckle twice with coconut oil (Trt 4, $n = 886$). A total of 10 mL of coconut oil was given by stomach tube to piglets in Trt 2 and Trt 4. Fostering was limited and was only done within treatment. There was no difference ($P < 0.05$) in sow parity, number of pigs born alive, piglet birth weight, number of pigs weaned or age at weaning among treatments. There was a significant ($P < 0.05$) effect of treatment on weaning weight, piglet weight gain and piglet average daily gain. Piglets allowed to split suckle twice with or without coconut oil gained more weight, gained weight more rapidly and were heavier at weaning compared with piglets allowed to split suckle only once with or without coconut oil (Table 1; Trt 2 and 4 vs Trt 1 and 3). There was no difference ($P < 0.05$) in mortality between treatments. These results indicate that split-suckling twice benefited the piglets and resulted in improved piglet growth performance. There

was no difference in piglet growth performance between Trt 2 and Trt 4 or Trt 1 and Trt 3; therefore administering coconut oil had no effect on the piglets' performance or survivability.

Table 1.

	Total Gain (Kg)	ADG (Kg/day)	Weaning Weight (Kg)
Treatment 1	3.48	0.163	4.75
Treatment 2	3.71	0.173	4.98
Treatment 3	3.52	0.164	4.78
Treatment 4	3.65	0.171	4.93

350 Use of infrared temperature guns to determine body temperatures of dairy calves. M. A. Laws,* K. A. Hoeing, T. S. Dennis, M. M. Schutz, M. W. Grott, and T. D. Nennich, *Purdue University, West Lafayette, IN.*

Body temperature measurements are an indicator of calf health. Obtaining rectal temperatures are often labor intensive as it requires calf restraint. A method to obtain body temperatures that does not require calf restraint would improve the practicality of measuring body temperature of calves. The objective of this study was to determine the precision of infrared temperature guns to measure temperature from various locations on the hide of calves and to determine if infrared temperature gun measurements were correlated to rectal temperature. An infrared temperature gun with a surface and body temperature setting (G1S and G1B) and a second gun (G2) were used to obtain temperatures from various points on Holstein heifer calves. Points measured on calves included the muzzle, back, eye, base of the ear, and peri-anal area. Hide color was also recorded. Rectal temperature and infrared temperature readings (n = 201) were measured at the same time and collected from 33 calves on different days. The infrared temperature guns were also used to measure temperatures of hutch bedding material and outside pen floors. Temperature readings from each body point were correlated to rectal temperature using Proc Corr of SAS with Pearson correlation coefficients. The strongest correlations to rectal temperature were found using G1B at the ear base ($r = 0.34$; $P < 0.001$) and G1S at the muzzle ($r = 0.31$; $P < 0.001$). Correlations were improved when the hide was black, with correlations between rectal temperature and the ear base of $r = 0.36$ ($P < 0.001$) and $r = 0.20$ ($P = 0.38$) for black and white hides, respectively, using G1B. The strongest correlations between guns were $r = 0.65$ ($P < 0.001$) for G1S and G2 for the back and $r = 0.41$ ($P < 0.001$) between G1B and G2 for the ear base. However, the correlation between G1S and G2 on the pen floor was $r = 0.74$ ($P < 0.001$). Infrared temperature guns used in this study were not a reliable means of determining body temperature of calves, but did appear to be more accurate when measuring solid surfaces.

Key Words: calves, body temperature, infrared gun

351 Evaluation of the phenotypic correlations between feed efficiency measures in postweaning heifers and cows during their first lactation. M. E. Anderson,* K. A. Gray, G. R. Hansen, M. H. Poore, C. S. Whisnant, and J. P. Cassady, *North Carolina State University, Raleigh.*

The objective of this study was to evaluate relationships that exist between measures of feed efficiency in beef cattle during postweaning growth and their first lactation. Data were collected from 109 first-calf,

Angus females from the North Carolina State University herd, which is maintained at the Upper Piedmont Research Station in Reidsville, NC. Data were collected over a 3 year period in which developing heifers were trained and fed in a CALAN gate feeding system for 84 d and subsequently returned for another feed collection period during their first lactation for 42 d. A fescue hay diet was used for both cows and heifers to simulate a realistic pasture based diet. Feed offered and orts were recorded daily and weekly, respectively. These feed measurements were used to estimate DMI. All animals including calves were weighed every 14 d during their respective test; these weights were used to calculate ADG, which was estimated by linear regression of weight on time. Means for DMI and ADG for postweaning heifers were 6.7 ± 0.11 kg and 0.93 ± 0.017 kg, respectively. Means for DMI and ADG for first lactation cows were 12.7 ± 0.19 kg and 0.46 ± 0.040 kg, respectively. Residual feed intake (RFI) was calculated. Heifer RFI was calculated by a model including the dependent variable DMI and covariate of mid weight on test. Cow RFI was calculated by a model including the dependent variable DMI and covariate of mid weight on test and its calf's ADG. Phenotypic correlations were estimated while adjusting for year in postweaning heifers and cows using the CORR procedure in SAS. A negative correlation of DMI was observed ($r = -0.16$, $P = 0.09$). The correlation between postweaning heifer and first-calf heifer RFI was ($r = 0.12$, $P = 0.21$). It was concluded that in this study RFI in developing heifers was not a good predictor of RFI in first-calf heifers.

Key Words: beef cattle, feed utilization, RFI

352 Effects of actigen on cytokine production by porcine leukocytes. A. M. Daniels,* T. M. Che, and J. E. Pettigrew, *University of Illinois, Urbana.*

Previous results from our laboratory showed that a mannan oligosaccharide product (Bio-Mos[®], Alltech, Inc.) induced pro-inflammatory cytokine secretion by bronchoalveolar lavage fluid cells (BALFC). This study was conducted to determine whether a more refined mannan product (Actigen[®], Alltech, Inc.) has similar in vitro effects. The BALFC were obtained from 6 pigs at 5 wk of age, applied to 24-well cell culture plates at the rate of 2×10^5 cells/well, and incubated with cell culture medium overnight to allow macrophages to adhere to the plate. After washing away the unattached cells, the Actigen-containing cell culture medium was added to the wells to activate the adherent cells which were then incubated for 24 h more before the collection of supernatants. Peripheral blood mononuclear cells (PBMC) were isolated from pig blood by gradient centrifugation using ficoll gradient (Histopaque 1077), processed similarly, and plated at a density of 1×10^5 cells/well. The application levels of Actigen were 0, 1, 2, 3, 4, or 5 mg/mL. Concentrations of the cytokines tumor necrosis factor- α (TNF- α), IL-1 β , and IL-10 were measured in supernatants by ELISA. Data were analyzed by ANOVA using the GLM procedure of SAS with pigs as replicates. Linear and quadratic responses to Actigen were tested. The anti-inflammatory cytokine IL-10 was not detectable in any of the supernatants. Actigen stimulated (linear effect $P < 0.05$; quadratic effect, NS) production of pro-inflammatory cytokines (TNF- α and IL-1 β) by both BALFC and PBMC. The TNF- α concentrations in supernatants from BALFC were 0.1, 7.3, 10.4, 15.4, 16.0 and 20.0 ± 1.2 ng/mL as Actigen increased from 0 to 5 mg/mL. For IL-1 β the values were 0.32, 0.68, 1.01, 0.92, 1.04 and 1.55 ± 0.14 ng/mL. The PBMC produced less of the cytokines, with the corresponding concentrations of 0, 52, 63, 127, 165 and 124 ± 32 pg TNF- α /mL and 17, 27, 26, 73, 101 and 105 ± 25 pg IL-1 β /mL. In conclusion, Actigen induced pro-inflammatory cytokine production from both BALFC and PBMC,

suggesting it may have important effects on the immune response.

Key Words: actigen, cytokines, swine

353 Antioxidant genes in weanling pigs fed organic and inorganic

Zn. R. L. Wangler*¹, P. S. D. Weber¹, J. E. Link¹, D. C. Mahan², and G. M. Hill¹, ¹*Michigan State University, East Lansing*, ²*The Ohio State University, Columbus*.

Pharmacological Zn in nursery diets was shown by our laboratory to alter gene expression. It is not known if Zn at physiological levels will affect gene expression similarly. Increased hepatic Zn stores from feeding excess Zn may increase the need for antioxidant enzymes. Therefore, the objective of our study was to evaluate the effect of Zn at recommended NRC levels from organic and inorganic sources on the expression of Metallothionein (MT), Peroxiredoxin 4 (PRDX4), Glyoxalase (GLO1), and Aminoacylase 1 (ACY1) in weanling pigs. At weaning, 18 pigs were allotted to 3 pens. Each pen was fed either 1) basal diet meeting nutrient needs except Zn, 2) basal diet + 100 ppm Zn Bioplex, or 3) basal diet + 100 ppm Zn sulfate. At 10 and 35 d, 3

pigs from each pen were killed and liver samples collected. RNA was isolated using 5 Prime Perfect Pure RNA Cell and Tissue Purification Kit and RNA purity, integrity, and quantity were determined using the Agilent Bioanalyzer. RNA samples with RNA Integrity Number (RIN) ≥ 9.0 were then converted to cDNA using Applied Biosystems High Capacity cDNA kit. Quantitative Real Time Polymerase Chain Reaction (qRT-PCR) was used with Taqman Gene Expression Master Mix, gene specific primers, and Taqman probes to measure expression levels of MT, PRDX4, GLO1, ACY1 and β -Actin. Delta delta Ct method and SAS linear mixed models were used to determine expression differences between treatments. There was a main effect ($P = 0.003$) of day upon hepatic PRDX4, with PRDX4 expression greater at d 10 than d 35. The expression of MT, GLO1 and ACY1 were not different by day ($P = 0.90$, $P = 0.61$, and $P = 0.19$, respectively) or by diet ($P = 0.07$, $P = 0.97$, and $P = 0.28$, respectively). Therefore, with a limited number of observations it appears that gene expression of these antioxidant genes is not increased with adequate Zn.

Key Words: pigs, zinc, antioxidant genes

POSTER PRESENTATIONS

Undergraduate Student Poster Competition

354 Effects of yeast source and viability on acidity and cellulose digestion by rumen fluid in vitro. C. E. Owens*¹ and F. N. Owens², ¹*Des Moines Area Community College, Des Moines, IA*, ²*Pioneer Hi-Bred International, Johnston, IA*.

Cattle diets often contain added yeast (*Saccharomyces cerevisiae*). Several companies market various strains of yeast; some are live and active while others are not guaranteed to be viable. Because yeast is aerobic and the rumen is anaerobic, yeast will not thrive in the rumen. To test if source and viability of yeast influenced fermentation by rumen microorganisms, 1 g quantities of yeast, either live or killed (water suspensions boiled until catalase measured using hydrogen peroxide was absent), from 8 different commercial sources (bread, baking, and wine forms) were incubated in triplicate with 35 mL of rumen liquid in capped plastic tubes with or without glucose added at a concentration equal to that observed at the onset of ruminal acidosis (5.6 mM). Effects of treatments (added glucose, yeast source, yeast viability) on pH after 1, 16, 41, and 89 h of incubation at 39°C and on mass of cellulose thread that had disappeared at 89 h were monitored. The pH declined steadily with incubation time; added glucose depressed pH further. Compared with dead yeast, live yeast resulted in lower ($P < 0.05$) pH at 16 h but higher ($P < 0.05$) pH at 89 h. The pH at 16 h differed with source of yeast. Disappearance of cellulose string was correlated with pH at 16 h ($R^2 = 0.77$). Of the 8 yeast sources tested, only one increased cellulose disappearance. Based on this in vitro study with ruminal fluid with added glucose, the response by rumen fluid in pH and in cellulose digestion would be expected to differ with yeast source and viability.

Key Words: yeast, viability, glucose, cellulose

355 Effects of corn addition to fiber-based supplements on growing cattle performance and forage digestion. S. J. Morine,* M. E. Drewnoski, and S. L. Hansen, *Iowa State University, Ames*.

Growing cattle grazing pasture are often supplemented to increase dietary energy intake and increase gains. Fiber-based supplements are often used to avoid potential negative associative effects of feeding large amounts of grain. However, low levels of corn may further increase performance beyond that of a highly digestible fiber-based supplement alone. The objective of this study was to determine the effect of inclusion of corn at 20 or 40% in a soyhull-based supplement on cattle weight gain and forage digestion when supplemented at 1% of BW. Fifty-four Angus-type steers (345 kg) were blocked by weight into 9 groups, and randomly assigned to treatment (trt) and 2.4 ha bromegrass plots (15% CP and 41% ADF). Dietary trt consisted of supplementation with soyhulls (SH), 80% SH and 20% cracked corn mix (C20) or 60% SH and 40% cracked corn mix (C40) at 1% of BW. Steers were strip-grazed and forage was allocated weekly at 3.5% BW•hd⁻¹•d⁻¹ (DM basis). Forage intake was estimated 3 times during the trial by determining forage disappearance in the weekly allocations and did not differ ($P > 0.10$) among trt. Steers were weighed on d -1, 0, 28, 56 and 57 and ADG calculated. The ADG of C20 and C40 did not differ ($P > 0.10$) but were greater ($P < 0.05$) than SH. Additionally, 8 ruminally-cannulated steers (409 kg) were fed ad-libitum bromegrass hay (10% CP and 44% ADF) alone (H) or were supplemented with

SH, C20, or C40 at 1% of BW in a replicated 4 × 4 Latin square design with 14 d periods. Effect of trt on forage digestion was measured by 48 h in situ incubation of hay on the last 2 d of each period. Ruminal pH was measured at 6 h after feeding on d 14 and was greater ($P = 0.02$) in H than the supplemented trt. However, there was no difference ($P > 0.10$) among supplemented trt. Hay digestion did not differ among trt ($P > 0.10$). The results of this study suggest that adding cracked corn at 20 or 40% of a fiber-based energy supplement can increase growth of grazing cattle without negatively affecting forage digestion.

Key Words: cattle, soyhulls, corn, forage digestion

356 The effects of Excede (ceftiofur crystalline free acid) vaccine for swine on the mortality rate of the Wilmington College goat flock. K. Matuch,* H. Thirey, M. Anderson, and R. L. Gerber, *Wilmington College of Ohio, Agriculture Department, Wilmington*.

The boer crossbred herd of goats on the educational farms at Wilmington College have had an interesting history. Looking at data from 2005 to 2010 the mortality rates of kids each kidding season had been average, until 2009. In 2009 there was a 45% mortality rate, of the 51 kids born, 23 of them did not survive. Management practices were assessed and changed, the barn was insulated, a new bedding source was found, and a veterinarian was consulted. An extra label drug usage was prescribed to the herd, 1/4 mL of Excede (ceftiofur crystalline free acid) vaccine for swine was to be administered at birth. In 2010, a dramatic change was noted, a 8.9% mortality rate, of the 56 kids born, 5 died, of those that died 4 had not been treated with the vaccine, the remaining kid was treated however the death is believed to not be attributed to the infection. Which raises the question, does the Excede (ceftiofur crystalline free acid) vaccine make a significant difference in the mortality rate among goats? The purpose of this specific study to observe and record the effects of the Excede vaccine (ceftiofur crystalline free acid) for swine on the mortality rate of this specific herd, while holding other variables constant such as, insulation of the barn and clean bedding, by once again vaccinating only the odd numbered kids at birth with 1/4 mL of Excede (ceftiofur crystalline free acid).

Key Words: ceftiofur crystalline free acid, goats, Wilmington College, mortality rate

357 Investigations into the reliability of a sow lameness scoring tool. C. Burrack,* R. Parsons, L. Karricker, K. Stalder, A. Butters-Johnson, C. Wang, and S. Millman, *Iowa State University, Ames*.

Lameness is a major problem in swine production that decreases production and compromises animal welfare. It is important to evaluate the lameness status of swine using an easy, quick, and repeatable method. The objective of this study was to evaluate the inter-observer reliability of a 4-point locomotion scoring system for sows (using a standardized library of recorded images). Twelve sows were videotaped while they were sound and after lameness was induced by an injection of amphotericin B into the distal interphalangeal joints of one rear limb. Video images showed the sows walking toward and away from the observer. Video images were uploaded into a WebCt assessment and

coded to ensure blinding of observers. Seventeen observers were asked to review the educational materials for the Zinpro 4-point lameness scoring system, and then to score the sows in the video images. The inter-observer reliability of locomotion scores for individual sows was high. For all sows, the average agreement between observers was 71%. There was more agreement for some images (94%) than others (53%) which may reflect variability in sow gait. In conclusion, the locomotion scoring system was found to be a beneficial tool for evaluating lameness, but could be further refined to account for gait variability found in individual sows.

Key Words: lameness, sow, scoring system

358 Glucose meter accuracy when used on dairy calves. M. R. Stafne* and S. I. Kehoe, *University of Wisconsin, River Falls.*

Measuring glucose levels in calves is a key component in many research studies. However, testing the glucose levels at a laboratory can prove to be expensive and can delay progression of a project if the data are needed immediately. As an alternative to laboratory testing, it was hypothesized that a hand-held glucose meter would provide the same accurate results but faster. Therefore, the objective of the study was to determine the accuracy of a glucose meter when used on dairy

calves compared with results from a laboratory test. Sixty-eight samples were collected from 34 calves with a 2 week interval between the 2 sampling periods. Testing and housing of the calves was performed at Merrick's Research Facility (Union Center, WI). The calves used were fed a standard 20/20 milk replacer at 10 oz. DM per day which included various supplements due to an ongoing nutrition trial. Calves were housed in plastic hutches and were fed water and grain (18% CP; Prince, Marshfield, WI) ad libitum. Blood was collected using a blood collection vacutainer containing sodium fluoride (BD Diagnostic Systems, Franklin Lakes, NJ). Samples were first tested on whole blood using a glucose meter and then centrifuged. Plasma was extracted using a pipette and frozen for later analysis at Marshfield Laboratories (Marshfield, WI). Measurements were statistically analyzed using the Proc Ttest in SAS 9.2 and were determined significant at $P < 0.05$. Least squares means for the laboratory glucose test and glucose meter were 93.97 ± 17.79 mg/dL and 121.66 ± 25.84 mg/dL, respectively ($P < 0.001$). It was concluded that the 2 testing methods did not produce comparable results. The variation in glucose concentration may have been due to the type of blood sample needed to run each test. Additional research containing more samples and other various tests would be recommended.

Key Words: glucose, calves, glucose meter

AUTHOR INDEX

Numbers following names refer to abstract numbers, not page numbers. The author index is created directly and automatically from the abstracts. If an author's name is typed differently on multiple abstracts, the entries in the author index will reflect these discrepancies. Efforts have been made to make this index consistent, however, errors from author entry contribute to inaccuracies.

- A**
- Aalhus, J., 162
Aarsse, F., 101
Abdullah, M., 315
Abell, C. E., 39, 87
Abrams, S., 44
Adcock, J. W., 81, 86
Adeola, O., 46, 221
Aguerre, M. J., 295
Agyekum, A. K., 122
Ahern, N. A., 296
Aitken, R. P., 335
Albin, D. M., 263
Alexander, L. S., 231
Allee, G., 167, 173, 174, 239
Allen, R. M., 184
Almeida, F. N., 47, 225
Al-Rammahi, M., 284
Amanlou, H., 327
Am-in, N., 111
Amiri, F., 327
Amodie, D., 80
Anderson, D., 207, 223, 224
Anderson, J. E., 8, 9
Anderson, M., 356
Anderson, M. E., 351
Anderson, P., 45
Anil, L., 75, 222
Anil, S. S., 75
Ao, X., 130
Apple, J. K., 94, 136
Applegate, T. J., 221
Araiza, A. B., 212
Araiza, B. A., 216
Arango, J., 29
Arndt, C., 295
Asmus, M. D., 255
Ata, M., 329
Atkinson, R. L., 322
Austin, K. J., 37
Avelar, E., 216
Avenida, S., 30
Ayangbile, G. A., 263
Ayoade, D., 49
- B**
- Baas, T. J., 77
Badtram, G., 17
Baidoo, S. K., 75, 100, 106, 153, 156, 213, 222
Baker, S. R., 226
Ball, R. O., 50
Banks, P. M., 221
Barham, B. J., 322
Barnes, J. A., 151, 152, 169, 211
Barrera, M., 212
Bass, B., 181
Bass, B. E., 51, 228
Batchelor, D., 250, 284
Bates, R. O., 340
Bauer, M. L., 348
Baumgard, L. H., 290
Baxter, E. M., 124
Beaulieu, A. D., 116, 236
Bedford, M. R., 181
Bee, G., 140
Beever, J. E., 34
Beitz, D. C., 137, 310
Belknap, C., 96
Bello, N. M., 62
Beltranena, E., 158, 160, 161, 162, 165, 185, 249
Bennett, G. L., 43
Benton, J. R., 92, 301, 306, 307
Berg, E. P., 113
Berg, P. T., 309
Bergamasco, L., 2
Bergstrom, J. R., 11, 102, 145, 146, 237, 241, 255, 256
Bertoni, G., 336
Bewley, J. M., 68
Bible, M., 155
Bidner, T. D., 170, 189, 242
Bionaz, M., 336
Bird, S., 104
Bishop, J. A., 78, 93
Blasi, D., 90
Boddicker, N., 44, 112
Boehmer, B. H., 285, 288
Boesche, K. E., 123
Bohnert, T., 26
Boler, D. D., 143
Boling, J. A., 328
Booher, C., 234, 235
Borowicz, P. P., 335
Bovey, K., 4
Bowman, R., 14, 16
Boyd, J., 76
Boyd, R. D., 51, 56, 98, 233, 234, 235, 247
Bradley, C. L., 51, 228
Bravo, D., 250, 126, 265, 284
Bremer, V. R., 294, 308
Brennan, K. M., 328
Brewer, S., 26
Bridges, G. A., 54, 127
Broomhead, J., 103, 193
Brown, P. K., 263
Browne, N. A., 94
Buchanan, D. S., 338
Buckner, C. D., 308, 311, 316, 317, 347
Bundy, J. W., 105, 199, 217
Burgett, R. L., 323
Burkey, T. E., 105, 199, 217
Burrack, C., 357
Burris, W. R., 328
Bursian, S. J., 267
Butters-Johnson, A., 357
- C**
- Cabrera, V. E., 66
Cadogan, D. J., 248
Caldwell, J. D., 329
Calkins, C., 117, 147
Camacho, L. E., 273
Camilo, P., 140
Cammack, K. M., 37, 38
Campbell, N., 161, 162
Campbell, R. G., 172
Capper, J. L., 292
Carlson, M. S., 73
Carmack, J. M., 322
Carr, S. N., 260
Carr, T., 117
Carter, S., 155
Carter, S. D., 73
Casas, E., 43
Casper, D. P., 263
Cassady, J. P., 78, 93, 33, 35, 36, 351
Cast, W. R., 187
Caton, J. S., 270, 272, 273, 334, 335
Cecava, M. J., 314, 316
Cera, K., 260
Cervantes, M., 212, 216
Cervantes-Pahm, S. K., 232
Charal, J., 243
Charal, J. W., 189
Chaytor, A. C., 128, 259
Che, T. M., 107, 126, 196, 197, 264, 265, 352
Chester-Jones, H., 64
Chi, F., 103, 193
Chipman, A., 178
Chipman, A. L., 203, 246
Chitko-McKown, C. G., 43
Choi, S. W., 103, 193
Chung, T. K., 138, 139
Ciobanu, D., 26, 42
Ciobanu, D. C., 25, 92
Claeys, M. C., 331
Clark, S., 99
Claus, J. R., 17
Close, W. H., 204
Coetzee, J., 5, 18
Coetzee, J. F., 2
Coffey, J. D., 138, 139
Coffey, K. P., 329
Cole, A., 293
Collins, M. T., 41
Connor, J., 167, 173, 174, 239
Conrad, E. C., 84
Cook, N. B., 70
Corah, L. R., 333
Cortus, E., 77
Cowieson, A. J., 48
Cox, R., 104
Cox, R. B., 148, 149, 150, 304, 305
Crane, J. P., 74
Crawford, G., 312, 318
Crawford, G. I., 96, 104, 149, 304, 305
Cromwell, G. L., 179, 182, 202
Crowder, S. A., 101
Csallany, A. S., 208
Culbertson, M. S., 78, 93
Culham, A. B., 344, 345
Cushman, R. A., 52
- D**
- Dahlberg, J. L., 304, 305
Dahlke, G., 73
Danfær, A., 245
Daniels, A. M., 352
Daniels, K. M., 123
Dasari, M. A., 186
Davis, D. L., 277
Dawson, K. A., 196, 264
Day, M. L., 54
de Lange, C. F. M., 79, 82, 91, 131
de Mello, A., Jr., 117
De Vries, A., 67
DeDecker, A. E., 7, 12, 95
Deen, J., 8
DeJarnette, J. M., 55
Dekkers, J. C. M., 29, 28, 30, 44, 112
Dennis, T. S., 350
DeRouchey, J. M., 10, 11, 73, 74, 97, 102, 120, 145, 146, 151, 152, 169, 188, 190, 191, 198, 205, 206, 210, 211, 220,

- 237, 241, 254, 255, 256, 261
 Desaulniers, A. T., 271
 Dewitt, D., 60
 Dhakal, K., 61
 Dhuyvetter, K., 280
 Dib, M. G., 300
 DiCostanzo, A., 96, 104, 149, 304, 305, 312, 318
 Diekman, M. A., 339
 Diex-Gonzalez, F., 304, 305
 Dikeman, M., 90, 142
 Doerr, A. J., 301
 Donkin, S. S., 281
 Donsbough, A., 242
 Döpfer, D., 70
 Dorsam, G. P., 269
 Dourmad, J. Y., 227
 Downey, E. D., 84
 Downing, T., 71
 Dozier, W. A., 175
 Drackley, J. K., 109, 336
 Dreadin, T., 234
 Drownoski, M. E., 137, 310, 313, 355
 Dritz, S. S., 10, 11, 74, 97, 102, 120, 145, 146, 151, 152, 169, 188, 190, 191, 198, 205, 206, 210, 211, 220, 237, 241, 254, 255, 256, 261
 Drouillard, J., 90, 142
 Duan, Q., 137
 Dugan, M., 162
 Dusick, A. F., 70
- E**
- Eastwood, L., 116
 Edwards, D. B., 340
 Edwards, L. N., 2, 254
 Einstein, M. E., 233, 234, 235, 339
 Ellis, M., 14, 15, 16, 218, 219, 243
 Elmore, M. R. P., 6
 Endres, M. I., 320
 Ensley, S. M., 310
 Erickson, G., 117, 147
 Erickson, G. E., 85, 92, 114, 294, 296, 297, 298, 299, 300, 301, 303, 306, 307, 308, 311, 314, 316, 317, 330, 347
 Ernst, C. W., 340
 Erskine, R. J., 62
 Estienne, M. J., 20, 24
 Everts, R. E., 336
- F**
- Faulkner, D. A., 342
 Faulkner, D. B., 34, 81, 86, 346
 Faylon, M. P., 287
 Felix, T. L., 110, 332, 341
 Fent, R. W., 154
 Ferdinand, N. N., 25
 Fernández, J. A., 245
 Fernando, R., 29, 30
 Fernando, R. L., 28, 31, 137
 Ferrel, J., 207, 223, 224
 Fields, B., 233, 235
 Fink, R. C., 304, 305
 Finn, A. M., 248
 Fisher, D., 289
 Flowers, W. L., 21, 108, 238
 Ford, Q. D., 339
 Forsberg, N. E., 144
 Forster, L. A., 322
 Foxcroft, G. R., 101
 Fralick, C., 233, 234, 235
 Frank, J. W., 51
 Frerichs, K. A., 209
 Fritchen, A. N., 141
 Fritz, E., 44
 Frobose, H. L., 194, 195, 205, 206, 254
 Frugé, E. D., 194, 195
 Fulton, J. E., 29
 Furman, S. A., 299, 330
- G**
- Gabler, N. K., 115, 257, 290
 Gahlke, G., 60
 Gaines, A. M., 218, 219, 243
 Galeota, J., 26
 Gamroth, M., 71
 García, H., 216
 Garmyn, A. J., 137
 Garner, J. P., 6
 Garrick, D., 31
 Garrick, D. J., 28, 29, 30, 32, 44, 84, 112, 137
 Gasca, S. J., 95
 Gay, B. S., 267
 Gay, D. L., 321
 Gebhart, K., 349
 Geisert, R. D., 132
 Gerber, R. L., 356
 Gerlach, B., 142
 Gerrard, D. E., 124
 Goehring, B., 142
 Golombeski, G. L., 64
 Gomez, A., 70
 Gonda, M., 40
 González, D., 212
 Gonzalez, J. C., 166
 Goodall, S. R., 330
 Goodband, R. D., 10, 11, 74, 97, 102, 120, 145, 146, 151, 152, 169, 188, 190, 191, 198, 205, 206, 210, 211, 220, 237, 241, 254, 255, 256, 261
 Gowanlock, D. W., 88
 Graham, J., 229
 Grandin, T., 17
 Grant, J. K., 119, 348
 Graugnard, D. E., 336
 Gray, K. A., 36, 351
 Grazul-Bilska, A. T., 270, 335
 Green, J. A., 132
 Greiner, L., 167, 173, 174, 239
 Grewell, D., 99
 Griffin, W. A., 92, 297, 298, 300, 301, 303, 306, 307, 314
 Grott, M. W., 350
 Grubbs, J. K., 141
 Gugle, T. L., 262
 Gunn, P. J., 54, 127
- H**
- Haack, A., 117, 147
 Habier, D., 29, 30
 Hagen, C., 13
 Hale, R. L., 333
 Hall, R. J., 263
 Hall, Z. C., 121
 Hallford, D. M., 272
 Hammer, C. J., 273
 Hancock, J. D., 262
 Hanford, K. J., 121
 Hanigan, M., 293
 Hansen, E., 211
 Hansen, E. L., 187, 194, 195, 209
 Hansen, G. R., 351
 Hansen, J. A., 128, 259
 Hansen, S. A., 194, 195, 209
 Hansen, S. L., 310, 313, 355
 Hanson, A. R., 12, 95
 Haring, J. S., 269
 Harrell, R. J., 157
 Harris, E. K., 113
 Harris, S., 26
 Harrison, J., 69
 Hart, J., 71
 Hassen, A., 184
 Hassen, A. T., 65
 Hempel, M., 61
 Heo, P. S., 215
 Hergenreder, J., 117, 147
 Hernández, J., 160
 Herrick, K. J., 315
 Herring, W. O., 78, 93
 Hess, B. W., 334
 Hicks, J., 80
 Higgins, E. E., 124
 Hilbrands, A. M., 150, 213
 Hill, G. M., 176, 177, 267, 344, 345, 353
 Hines, E. A., 138, 139
 Hinkle, E. E., 105, 199, 217
 Hippen, A. R., 315
 Hoeing, K. A., 350
 Hojer, N. L., 321
 Holden, P. J., 77
 Hölker, M., 274
 Holl, J. W., 93, 78
 Holt, J. P., 118, 214
 Hong, S. M., 130
 Hoover, T., 80
 Hostetler, C., 229, 349
 Houser, T., 90, 142
 Houser, T. A., 102, 145, 146
 Hristov, A. N., 293
 Htoo, J., 82
 Htoo, J. K., 91, 171
 Huang, Y., 35
 Hubbell, D. S., III, 329
 Huber, L., 91
 Hubert, M. B., 321
 Huff-Lonergan, E., 141
 Hunter, A. L., 123
- I**
- Iiams, J. C., 184
 Invernizzi, G., 109
 Ionescu, C., 250, 284
 Ipharraguerre, I., 240
 Ippolito, J., 72
 Ireland, F. A., 342, 346
 Isaacson, B. W., 14
 Issa, S., 262
- J**
- Jacobs, B. M., 175
 Jacques, K., 76
 Jacques, K. A., 204
 Jaderborg, J., 318
 Jaderborg, J. P., 96, 304, 305
 Jang, H. D., 129
 Jendza, J. A., 75, 222
 Jenkins, K. H., 299, 330, 347
 Jensen, D., 349
 Jha, R., 251
 Ji, P., 109
 Johnson, A., 5, 18
 Johnson, A. K., 6
 Johnson, D., 117
 Johnson, R., 26, 42
 Johnson, R. K., 19, 25
 Johnson, R. W., 196, 264
 Johnson, T. M., 94
 Johnson, Z. B., 51, 228
 Johnston, L. J., 9, 8, 100, 106, 150, 153, 213
 Jolliff, J. S., 176
 Jondreville, C., 227
 Jones, C. K., 115, 203, 246, 257
 Jones, D., 219
 Jones, D. B., 184
 Jørgensen, H., 245
 Ju, W. S., 163
 Jung, J. H., 200
 Jung, S., 99
 Jungst, S., 167, 233, 234, 235
- K**
- Kachman, S., 26
 Kachman, S. D., 25
 Kallenbach, R. L., 302

- Kalscheur, K. F., 315
Kandel, K., 158
Karges, K., 321
Karges, K. K., 309
Karimzadeh, S. M., 319, 326
Karricker, L., 357
Karriker, L., 5, 18
Kebreab, E., 245
Keele, J. W., 43
Keever, B. D., 159
Kegley, E. B., 228, 329
Kehoe, S. I., 358
Kelley, K. W., 196, 264
Kelly, D., 207, 223, 224
Kelzer, J. M., 104, 149
Kendall, D. C., 128, 259
Keown, J. F., 61
Kerley, M. S., 59
Kerr, B. J., 175, 201
Kerrigan, M., 44
Keys, C. A., 94
Kiarie, E., 49, 252
Killefer, J., 143, 159
Kim, B. G., 226
Kim, D. H., 215
Kim, H. J., 130, 155
Kim, I. H., 103, 129, 130, 193, 200
Kim, S. W., 108, 128, 238, 259
Kim, Y. H., 141
Kim, Y. Y., 215
King, V. L., 74
Kirkden, R. D., 6
Kirkpatrick, B. W., 41
Kirkwood, R. N., 111, 283
Kitt, S., 349
Kizilkaya, K., 31, 137
Kleinschmit, D. H., 263
Klopfenstein, T. J., 85, 114, 294, 296, 297, 298, 299, 300, 301, 303, 306, 307, 308, 311, 314, 316, 317, 347
Klusmeyer, T. H., 306, 307
Knott, J. S., 154
Knox, R., 77
Kocher, M., 218, 219
Koketsu, Y., 125
Koltjes, D. A., 286
Korn, K. T., 331
Kovarik, L. M., 121
Kranis, A., 30
Kuehn, L. A., 43
- L**
- LaBerge, R. J., 148, 150
Lamberson, W. R., 37, 38, 271, 289
Lamont, S. J., 29, 30
Lanz, G., 161
Lardy, G. P., 134, 309
Laws, M. A., 350
Ledoux, D. R., 37
Lee, J. D., 214
Lee, J. W., 159
Leedom, K., 77
Leesburg, V. L., 35
Lehmkuhler, J. W., 57, 58
Lekatz, L. A., 269
Lemenager, R. P., 331
Lemley, C. O., 269, 272
Lents, C. A., 275
Leterme, P., 116
Létourneau-Montminy, M. P., 180, 227, 230
Leuer, R. F., 320
Lewin, H. A., 336
Li, X. J., 106
Li, Y., 77
Li, Y. Z., 8, 9
Li, Z., 243
Liao, S. F., 328
Liesman, J., 111, 343
Lindemann, M. D., 179, 182, 202
Lindquist, R. U., 300
Link, J. E., 176, 177, 267, 344, 345, 353
Linn, J., 64
Lintz, K. K., 84
Liptrap, D. O., 154
Litvak, N., 82
Liu, F., 244
Liu, P., 156
Liu, Q., 137
Liu, X., 244
Liu, Y., 107, 126, 265
Lock, S. L., 282
Loersch, S. C., 110, 123, 332, 341
Lonergan, S. M., 141
Looper, M. L., 329
Loor, J. J., 109, 336
Lovatto, P. A., 180
Loy, D. D., 310
Lu, A., 244
Lucy, M. C., 89, 132
Lukas, J. M., 320
Lunney, J. K., 44, 112
Luxford, B. G., 192
- M**
- Ma, T., 61
Ma, Y. L., 182
Mabry, J. W., 39, 87
Macek, M., 90
MacNeil, M. D., 35
Maddox, C. W., 107, 265
Magnin, M., 230
Mahan, D. C., 88, 176, 177, 328, 353
Main, R. G., 115, 257
Mallory, D. A., 282
Maltecca, C., 33, 35, 36
Manjarin, R., 111, 283, 343
Mark, D. R., 85, 308
Martin, J. L., 121
Martin, R., 56
Martin, R. E., 154
Martin, W. R., 89
Martinez-Ramirez, H. R., 131
Mateescu, R. G., 137
Mathew, D. J., 89, 132
Matthews, J., 167
Matthews, J. C., 328
Matthews, N., 233, 235
Matuch, K., 356
Maxwell, C. V., 51, 83, 94, 181, 228
May, K. D., 83
McAllister, T. A., 293
McArdle, T., 76
McClelland, K. M., 148, 150, 304, 305
McDaneld, T. G., 43
McGrath, M., 247
McKeith, F. K., 159
McKilligan, D., 120
McKilligan, D. M., 190, 191
McKinney, L. J., 262
McKnite, A., 26
McKnite, A. M., 25
McNamara, T. J., 148, 150
Meeuwse, D. M., 74
Meisinger, D. J., 73, 77
Meme, N., 230
Méndez, V., 212
Mendoza, O. F., 219, 243
Meng, Q. W., 200
Merriman, L. A., 118
Mescher Collins, K., 77
Meter, W. T., 86
Meyer, A. M., 272, 273, 334, 335
Miah, A. G., 274
Middleton, T. F., 128, 259
Miller, K., 90
Miller, P., 19
Miller, P. S., 25, 105, 199, 217
Millman, S., 1, 5, 13, 18, 357
Milne, J. M., 335
Minero, K., 216
Mitchell, M., 192
Moeller, S., 77
Mooser, A. J., 266
Moline, J., 120, 190, 191
Monegue, H. J., 179, 202
Monegue, J. S., 179
Moore, K. L., 172
Morales, A., 212, 216
Morales, J., 171
Moran, A., 250, 284
Morrison, S. J., 355
Morrison, D., 60
Morrow, M., 77
Moural, T., 26
Mullan, B. P., 172
Muller, S., 140
Myers, A. J., 120, 190, 191, 241
- N**
- Naranjo, V. D., 189
Narcy, A., 230
Ndegwa, P. M., 293
Neill, C., 167, 173, 174
Nelson, D. A., 266
Nelson, P. C., 148, 150
Nelssen, J. L., 10, 11, 74, 97, 102, 120, 145, 146, 152, 169, 188, 190, 191, 198, 205, 206, 210, 220, 237, 241, 254, 255, 256, 261
Nelssen, J. M., 151, 211
Nemecek, J. E., 97, 188, 220
Nennich, T. D., 350
Neville, B. W., 309
Neville, T. L., 113, 270, 272, 273
Newman, D., 77
Newsom, E. M., 132
Nichols, C. A., 299, 311, 330, 347
Nikkhah, A., 319, 326, 327
Nottle, M. B., 192
Nuttelman, B. L., 92, 296, 297, 298, 300, 301, 303, 306, 307, 314
Nyachoti, C. M., 49, 122, 252
Nys, Y., 230
- O**
- Ochoa, L., 14, 16, 243
O'Diam, K. M., 123
Odle, J., 98
Offerdahl, E., 337
Oliver, W. T., 83
Olson, K. C., 90, 142, 321
Olson, T., 63
Omer, A. R., 268
O'Quinn, P. R., 128, 259
Oryschak, M., 162
Osorio, J. S., 109
O'Sullivan, N. P., 29
Osuna, O., 107
Ou, B. R., 144
Overman, E. L., 266
Overton, P., 36
Owens, C. E., 354
Owens, F. N., 65, 354
Owens, V. N., 321
- P**
- Pacheco, A., 90
Pajor, E. A., 6
Palan, R., 56
Pangeni, D., 222
Parish, J. A., 36
Parker, K. L., 33
Parsons, G., 90
Parsons, R., 18, 357

- Patience, J. F., 73, 115, 175, 178, 203, 246, 257
Paton, N., 260
Patterson, D. J., 53, 282
Patterson, J. L., 101
Patton, R. S., 315
Paulk, C. B., 262
Paulson, J., 63
Paulus, D. M., 96, 304, 305
Payne, R. L., 170, 217, 242
Pearce, S. C., 290
Pearson, E. L., 344
Perry, G. A., 52, 119, 348
Pesta, A., 147
Pesta, A. C., 298
Petersen, G. I., 168
Peterson, B. A., 14, 15, 16, 218
Peterson, C. M., 14, 15, 16, 218
Pettigrew, J. E., 107, 126, 196, 197, 264, 265, 352
Philipp, D., 329
Phillips, C. E., 8
Pickard, J. A., 204
Pierce, J. L., 182
Pike, C., 340
Pohl, S., 77
Pokharel, S., 117, 147
Pomar, C., 180, 227
Pomeranke, J. M., 100, 148, 153
Poock, S. E., 282
Poore, M. H., 351
Popowski, J. M., 104, 149, 304, 305
Porter, D., 291
Potter, M. L., 10, 11
Powell, J. G., 228
Powell, J. M., 295
Powell, S., 242
Preisinger, R., 29
Pritchard, R. H., 321
Pruitt, S. K., 92, 297
Prusa, K. J., 254
Puls, C. L., 14, 218
Puntenney, S., 144
Pye, T. A., 285, 288
- R**
- Radunz, A. E., 323, 324, 341
Raeth-Knight, M., 64
Rakhshandeh, A., 79, 82
Rambo, Z., 207, 223, 224
Ramos, M. H., 57, 58, 59
Rasby, R. J., 121
Rathje, T. A., 22
Ratliff, B. W., 120, 190, 191
Redmer, D. A., 270, 272, 273, 334, 335
Reecy, J. M., 44, 84, 112, 137
Reese, D. E., 73
Rempel, L. A., 279
Reneau, J. K., 320
Ressett, A. D., 321
- Retallick, K. M., 81, 86
Reynolds, L. P., 270, 272, 273, 334, 335
Reznik, G., 157
Rice, D. R., 184
Richert, B., 77, 207, 223, 224
Richert, B. T., 6, 73
Richter, E. L., 313
Ridenour, K., 229
Ridpath, J. F., 84
Rincker, M. J., 301
Risley, C., 240
Ritter, M. J., 260
Roberts, K. S., 38, 289
Rodriguez-Zas, S. L., 34, 336
Rojas, O. J., 164
Rojo, A., 218, 243
Rolf, M. M., 38
Rolfé, K. M., 92, 297, 311
Romero, L., 252
Rosenkrans, Jr. C. F., 329
Rosero, D. S., 98
Rothschild, M., 26, 44
Rothschild, M. F., 112
Rotz, A., 69, 293
Rousseau, X., 230
Roux, M. L., 242
Rowland, B., 112
Rowland, R. R. R., 44
Rowson, A., 144
Rozeboom, D. W., 267
Rplfe, K. M., 114
Ruiz Moreno, M., 312
Runnels, P. L., 74
Rupp, G. P., 52
Rustemeyer, S. M., 37, 38
Ryder, D., 206
- S**
- Saatchi, M., 32
Sadler, L., 13
Safranski, T. J., 89, 271
Salak-Johnson, J. L., 7, 12, 95
Salma, U., 274
Sangild, P., 284
Saraiva, A., 108, 238
Sarturi, J. O., 114
Sasaki, Y., 125
Sauber, T., 219
Sauber, T. E., 184
Schacht, W. H., 85, 297
Schaefer, D. M., 323, 324
Schaefer, M. R., 324
Schauer, C. S., 309
Scheer, T., 246
Schellander, K., 274
Schinckel, A. P., 233, 234, 235
Schingoethe, D. J., 315
Schoonmaker, J. P., 137, 331
Schroeder, A. R., 342
Schroeder, J., 325
Schutz, M. M., 350
- Schwartzkopf-Genswein, K. S., 3
Seabolt, B. S., 231
See, M. T., 77, 78, 93, 128, 259
Seitz, E., 312
Selby, C. C., 289
Senaratne, L., 117, 147
Seneviratne, R., 161, 249
Senn, M., 80
Serão, N. V. L., 34
Settar, P., 29
Sevenich, D., 184
Sexten, W. J., 302
Sharif, H., 61
Shelton, N. W., 254
Shi, X., 41
Shike, D. W., 81, 86, 342, 346
Shirazy-Beechey, S., 250, 284
Shook, G. E., 41
Shoup, L. M., 341
Shreck, A. L., 314, 316
Shull, C. M., 14, 15, 16
Shurson, G. C., 8, 100, 106, 148, 150, 153, 156, 201, 208, 213
Simmins, P. H., 252
Simmons, D., 133
Sims, M. D., 258
Skaar, G., 142
Skaar, G. R., 146
Slominski, B., 49
Slominski, B. A., 122
Smit, M. N., 101
Smith, B. L., 184
Smith, S., 56
Smith, T., 36
Smits, R. J., 192
Snelling, W. M., 43
Soares, J. A., 107, 197, 265
Socha, M., 64
Soltwedel, K., 205
Sonderman, J., 349
Sonderman, J. P., 22
Song, M., 107, 196, 197, 264, 265
Song, R., 208
Sorensen, B. L., 347
Sosnicki, A., 167, 233, 235
Sotak, K. M., 210
Soto, J., 173, 174, 239
Southern, L. L., 170, 189, 242
Souza, L. W. O., 156, 213
Spangler, D. A., 263
Spangler, M. L., 27, 92
Spencer, J. D., 101
Spiers, D. E., 89
Spring, P., 76
Spurlock, D. M., 286, 287
Stackhouse, R. J., 94
Stafne, M. R., 358
Stahl, C. H., 231
Stalder, K., 5, 18, 357
Stalder, K. J., 39, 87, 175
- Starkey, C. W., 138, 139
Starkey, J. D., 138, 139
Steibel, J. P., 44, 62, 111, 112, 283, 340, 343
Steichen, P. L., 348
Steidinger, M., 190
Stein, H. H., 47, 159, 163, 164, 166, 168, 183, 225, 226, 232, 253
Sterle, J., 77
Stern, M. D., 312
Stickel, A., 90, 142
Stiglbauer, K., 71
Stith, C. C., 302
Strathe, A. B., 245
Straw, B. E., 267
Stumpf, T. T., 22
Sulabo, R. C., 47, 163
Sun, X., 28
- T**
- Tait, R. G., 137
Tait, R. G., Jr., 84
Tapper, K., 18
Tart, J. K., 25
Taxis, T. M., 289
Taylor, N. P., 111, 283, 343
Taylor-Pickard, J. A., 76
Tedó, G., 240
Tempelman, R., 62
Teschfaye, D., 274
Thaler, R. C., 73
Thallman, R. M., 43
Thirey, H., 356
Thoma, G., 63
Thompson, L., 90
Todd, R., 293
Tokach, M. D., 10, 11, 74, 97, 102, 120, 145, 146, 151, 152, 169, 188, 190, 191, 194, 195, 198, 205, 206, 210, 211, 220, 237, 241, 254, 255, 256, 261
Torrey, S., 4
Tran, H., 105, 199, 217
Trevisi, E., 336
Tribble, B., 44
Trifilo, K., 111
Trottier, N. L., 111, 283, 343
Tsuji, H., 274
Tudor, K. W., 118, 214
Tuggle, C. K., 132
Turner, K. C., 267
Turpin, S., 17
- U**
- Unrine, J. M., 182
Unruh, J., 90, 142
Upah, N. C., 290
Urriola, P. E., 253
Usry, J., 173, 174
Usry, J. L., 51

V

Van Alstine, W. G., 196, 264
 van Benschoten, M. D., 345
 Van Eenennaam, A. L., 137
 van Heugten, E., 73, 98
 VanOverbeke, D. L., 137
 Varnold, K., 117, 147
 Vasconcelos, J. T., 114, 330
 Vaughn, M. A., 138, 139
 Veracini, J. L., 322
 Vijayakumar, S., 99
 Vogel, K. D., 17
 Vogelzang, K. D., 346
 Vonnahme, K. A., 113, 269, 270,
 272, 273, 334, 348
 Voogd, E., 17

W

Waguespack, A. M., 170, 189,
 242
 Walk, C. L., 181
 Walker, G., 229
 Walker, P. M., 7, 12, 95, 268,
 322
 Wallace, J. M., 335
 Walraven, T., 155

Walter, S. T., 333
 Wang, C., 13, 30, 357
 Wang, J. P., 103, 193
 Wang, X., 25, 26
 Wangler, R. L., 353
 Ward, J., 32
 Ward, T. L., 178, 228
 Warner, J. M., 121
 Watson, A. K., 85, 294, 297, 347
 Watson, K. A., 30
 Wattiaux, M. A., 295
 Weber, B. M., 306, 307
 Weber, L., 142
 Weber, P. S. D., 353
 Weber, T. E., 201
 Weilbaker, G., 135
 Wells, J. E., 83
 Wells, K., 37
 Wettemann, R. P., 285, 288
 Wey, D., 91
 Weyker, R. E., 17
 Wheeler, M. B., 278
 Whisnant, C. S., 351
 Whitacre, L., 27
 White, H. M., 281
 Whitney, M. H., 73
 Widmer, M. R., 154

Widowski, T. M., 4
 Wilcock, P., 181
 Williams, A. M., 23
 Williams, N., 167, 173, 174
 Williams, N. H., 23
 Williams, P., 258
 Williams, S. M., 262
 Wilmoth, T. A., 113
 Wilson, E., 234
 Wilson, M. E., 113, 178, 228
 Wilson, S., 76
 Wilson, T. B., 342
 Wolc, A., 29
 Wolter, B. F., 14, 15, 16, 218
 Wood, C. M., 124
 Wood, J. R., 276
 Woods, D. C., 282
 Woyengo, T. A., 122
 Wright, C. L., 348
 Wu, G., 111

X

Xiao, W., 243
 Xu, G., 120, 190, 191
 Xu, J., 244

Y

Yan, L., 129
 Yancey, J. W. S., 94
 Yáñez, J., 158, 160, 165
 Yang, B. U., 129, 200
 Yeum, K. -J., 108, 238
 Ying, W., 198, 261
 Young, A. N., 329
 Young, M., 161, 162
 Yunusova, R. D., 335

Z

Zamora, V., 111
 Zeng, X., 236
 Zhang, J., 79
 Zhang, S., 130
 Zhao, J., 157
 Zhao, P. Y., 200
 Zhao, Y., 108, 238
 Zhou, T. X., 129
 Zhu, C. H., 91
 Ziemer, C. J., 313
 Zier-Rush, C. E., 56, 247
 Zijlstra, R., 161, 162, 249
 Zijlstra, R. T., 158, 160, 165,
 185, 251

 **DANISCO**

First you add knowledge...

NUTRIQUEST™
