

**ABSTRACTS**  
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### Animal Behavior and Well-Being

**1 Can we understand farm animal welfare without taking into account the issues of emotion and cognition?**  
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Assessment of farm animal welfare is commonly based on measures of behavioral and physiological indicators of stress and coping. The implicit assumption is that welfare of farm animals is associated with successful adaptation to environmental conditions, whereas poor welfare is caused by failure of adaptation, as evidenced by significant alterations in behavior, stress hormones and possibly immune responses. However, this approach is insufficient if farm animals are considered as sentient creatures, capable of pleasure and displeasure, instead of simply reactive organisms. Although psychobiological responses to stress and negative emotional states have been intensively studied in farm animals, their ability to experience pleasure and the way this ability is altered by environmental factors have not been investigated. In addition, the study of emotional states in farm animals has been restricted to the description of emotional responses to the detriment of a proper consideration of the perceptive and cognitive processes underlying the corresponding emotional states. The present thrust of research in neuroscience on the relations between cognition and emotion provides a new framework for carrying out studies enabling to understand the mental world of farm animals and better defining the conditions for ensuring farm animal welfare.

**Key Words:** Cognition, Animal Welfare, Emotion

**2 Methods of assessing cognitive abilities of farm animals.** C. Croney\*, *University of Maryland*.

Concern for agricultural and research animal welfare has raised questions about the cognitive abilities of species used for these purposes, and the relationship between cognition and welfare. One approach to investigating farm animal cognition is to adopt established methods of comparative psychology to evaluate animals' specific mental processes, such as learning and memory. This approach has been used to study cognition in the domestic pig (*Sus scrofa*). In Experiment one, the ability of four Panepinto micropigs to form an olfactory discrimination learning set (DLS) was tested. This test, once used to assess animal intelligence, is now considered a useful paradigm for examining the ability to learn simple rules and to compare efficiency of learning across species. Three

pigs performed above chance on trial 2 on the last 50 blocks of DLS testing ( $P < 0.005$ ) indicating the pig can learn olfactory discriminations and form olfactory DLS's. In Experiment two, 2 Panepinto micropigs and 2 Yorkshire pigs were tested on ability to acquire a joystick-operated video-game task, an innovative, objective means of examining cognition. Pigs were required to move a cursor to make contact with 3-, 2-, or 1-walled targets randomly allocated to position on a computer screen. All were significantly above chance on first attempts to contact 1-walled targets ( $P < 0.05$ ). These results indicate that despite dexterity and visual constraints, the pig has the capacity to acquire a joystick-operated video-game task. Similar methodology may prove useful in future studies of the cognitive processes of farm animals, which should help us better understand their underlying mental abilities and how these abilities may be associated with their welfare.

**Key Words:** Cognition, Pigs, Olfactory learning, Video-task acquisition

**3 Cognition Studies With Pigs: Livestock Cognition And Its Implication for Production.** S. Held\*, M. Mendl, K. Laughlin, and O. Burman, *University of Bristol*.

The purpose of this paper is twofold. First, it discusses in general terms how animal production can be affected by the animals' cognitive abilities; secondly, it aims to introduce our work on pig cognition. The extent to which farm animals are positively or negatively affected by their housing and husbandry environments depends (amongst other things) on their cognitive abilities. It has long been known that predictability of and control over the variable aspects of their environment reduce the physiological symptoms of stress in animals. For the environment to be predictable, it must have some predictable properties, and the animal must realize that it does. To have control over its environment, the animal must learn and understand how the environment works and how it can be changed to its benefit. To this end, the animal must be able to perceive, store and use appropriately the pertinent environmental information. Research at Bristol investigates cognition in domestic pigs, particularly social cognition. An improved understanding of how much pigs understand about the behaviour and intentions of others may help reduce welfare and productivity problems. For example, being grouped and re-grouped with unfamiliar individuals is a common experience for domestic pigs at various stages in their lives. This often leads to high

aggression levels in the new groups with negative consequences for production. Research has shown that aggression levels are higher when unfamiliar pigs of the same (high or low) aggressiveness are mixed than when pigs of different aggressiveness are mixed. This implies that some social assessment and recognition takes place between individuals that allows them to judge each other's aggressiveness and to avoid fighting. Re-grouping of previously familiar pigs can also lead to high aggression levels. This suggests that pigs may be able to form only short-term social memories, or that their social memory is disrupted before re-grouping. Our research to date has focused on the memory abilities of pigs and their disruption by stressful husbandry procedures, on the pigs' ability to adjust their food-searching behaviour when paired with a competing co-forager, and on their ability to understand what others can and cannot see.

**Key Words:** Animal Cognition, Animal Production, Swine

**4 Heat stress mortality in Midwest feedlots.** T.L. Mader\*<sup>1</sup>, L.L. Hungerford<sup>2</sup>, J.A. Nienaber<sup>2</sup>, M.J. Buhman<sup>2</sup>, M.S. Davis<sup>1</sup>, G.L. Hahn<sup>2</sup>, W.M. Cerkoney<sup>1</sup>, and S.M. Holt<sup>3</sup>, <sup>1</sup>University of Nebraska, Northeast Research & Extension Center, Concord, NE, <sup>2</sup>Great Plains Veterinary Education Center or U.S. Meat Animal Research Center, Clay Center, NE, <sup>3</sup>Animal Production Dept., University of Queensland, Gatton College, Queensland, Australia.

An acute heat episode occurred in eastern Nebraska in July, 1999. During this period, the Nebraska Farm Bureau estimated that more than 5,000 cattle died with total production losses of \$21.5 to \$31 million. An investigation was conducted in four affected feedlots to identify factors associated with heat-related mortality. Total cattle mortality was 1.0% and 1.8% in the two largest feedlots (~8,000 head capacity) and 4% and 6.8% in the two smaller feedlots (~2,000 head capacity). Mortality in affected pens ranged from .3% to 26.3%. Initial cattle deaths occurred on the third day of which the maximum THI (temperature-humidity index) reached or exceeded the danger category. One of those days included a substantial rainfall in the affected area, > 3 cm, which compounded the already humid conditions. In both large feedlots, pens where mortality occurred had significantly greater numbers of cattle than control pens in which no deaths occurred, although differences in square meters per head were not significant. However, both control and affected pens had only one water tank per pen. During periods of heat stress, water requirements increase and cattle may congregate around water tanks. The degree of crowding, which decreases heat dissipation, may relate to space around tanks rather than total pen area per animal. In one of the larger feedlots, cattle in pens with heat related deaths were heavier ( $P < .01$ ) than control pens. In the other large feedlot, the percentage of black cattle was higher ( $P < .01$ ) in pens that experienced mortality than in those that did not. Analysis of data on pen location and color for individual animals showed that black cattle were at 5.7 times the risk for mortality as other cattle. Thermal stress occurred when cattle were unable to dissipate sufficient heat as a result of high heat load, humidity, and solar radiation combined with a lack of air movement and insufficient night-time cooling. As a result of cattle deaths, feedlot managers initiated intervention procedures based on observations of feed consumption and cattle behavior. THI was not used in decision-making prior to the event. Increased awareness of risk factors and THI warning levels could help producers plan for and effectively respond to extreme weather.

**Key Words:** Heat stress, Feedlot cattle, Mortality

**5 Effect of hut design on farrowing and lactation performance of pigs housed in a hoop structure.** A. V. Framp-ton\*, M. Ellis, G. Hollis, and S. E. Curtis, University of Illinois, Urbana, IL/USA.

The objective of the current study was to evaluate the effect of farrowing hut design on farrowing and lactation performance of sows group housed within a hoop structure. The two treatments consisted of different designs for the entrance to the farrowing hut. Half of the huts were fitted with a piglet retention roller bar designed to allow sows free access to the hut but to keep piglets within the hut. The entrance to the other huts had no roller bar present and piglets were free to move out of and into the hut. The study used a total of 48 primiparous and multiparous sows (24 per treatment) with 12 animals in each of four replicates. Sows were allotted by breed and parity to hut design treatment. Two hoop structures were used; each hoop structure was divided into two symmetrical

pens and each contained six huts. The experimental unit was considered to be the pen of six litters housed within a common hut design. The study was conducted during the months of June through August (mean temperature =  $23 \pm 2.8$  °C). Sows were given ad libitum access to a lactation diet that met or exceeded NRC (1998) requirements. Piglets were weaned at 23 d of age. Hut design did not influence the number of live piglets born per sow (13.1 vs. 12.0 piglets, for huts with roller and without roller respectively, SE = 0.66,  $P > 0.05$ ) or the number weaned per sow (5.3 vs. 5.1 piglets, for huts with roller and without roller respectively, SE = 0.81,  $P > 0.05$ ). High levels of mortality (60% of liveborn piglets) occurred within the hoop structure and hut design did not affect ( $P > 0.05$ ) mortality rate. Piglets reared in the hut without a door roller had higher weaning weights compared to those having a roller in the door (4.5 vs. 4.2 kg BW, for huts with roller and without roller respectively, SE = 0.09,  $P < 0.02$ ). In summary, individual huts fitted with a roller on the door resulted in lighter piglet weaning weights, but did not reduce piglet mortality within a hoop structure system.

**Key Words:** Pigs, Housing System, Lactation

**6 Effect of genetic selection for loin-eye area on behavior and whole blood serotonin levels in Landrace pigs.** S. Torrey\*<sup>1</sup>, S. Weaver<sup>2</sup>, E. Pajor<sup>1</sup>, D. Kuhlers<sup>3</sup>, and T. Stewart<sup>1</sup>, <sup>1</sup>Purdue University, West Lafayette IN, <sup>2</sup>USDA-ARS, Livestock Behavior Research Unit, West Lafayette IN, <sup>3</sup>Auburn University, Auburn AL.

To examine the behavioral and physiological differences in two genetic lines of pigs, Landrace gilts from a line selected for increased loin-eye area (n=30) and a contemporary random control line (n=32) were weaned and transported from Auburn University to Purdue University at an average age of 15 days. The select line differed from the control by 10 cm<sup>2</sup> after 6 generations of selection. Litters were grouped by farrowing date to minimize age differences and transported on two dates, 2 weeks apart. Four littermate gilts were penned together during transportation and in the nursery. Litters were videotaped continuously while in nursery to record behavioral traits. Individual blood samples were collected in late afternoon 9, 20, and 30 days after arrival to measure whole blood serotonin (WBS) levels. Daily maintenance behaviors, including percent of time spent lying, exploring pen, feeding and interacting with penmates, were examined over 29 days. Significant differences between genetic lines were seen for percent time spent lying (lean  $68.90 \pm 0.50\%$ , control  $71.66 \pm 0.50\%$ ;  $p=0.048$ ), exploring (lean  $16.12 \pm 0.33\%$ , control  $13.80 \pm 0.33\%$ ;  $p=0.009$ ), and interacting with penmates (lean  $4.22 \pm 0.22\%$ , control  $2.66 \pm 0.22\%$ ;  $p=0.005$ ). No significant difference was seen for time spent feeding (lean  $8.83 \pm 0.28\%$ , control  $9.59 \pm 0.28\%$ ;  $p=0.745$ ). There was no significant difference between the two genetic lines ( $p=0.479$ ) in latency to rest after initial transport; mean time was  $104.5 \pm 37.1$  minutes. Blood samples were assayed for WBS levels using HPLC methods. WBS concentration in the lean pigs ( $170.90 \pm 6.95$ ug/ml) was significantly higher than in the control pigs ( $140.69 \pm 6.42$ ug/ml) with  $p<0.0001$ . Our results suggest that a relationship exists between leanness, activity levels and WBS. This relationship may be utilized in selection processes to choose animals that are better adapted to their growing environment.

**Key Words:** Swine, Lean growth, Behavior

**7 Effect of sorting, removal and remixing on finishing pig performance.** M.C. Brumm\*<sup>1</sup>, M. Ellis<sup>2</sup>, L. J. Johnston<sup>3</sup>, D. W. Rozeboom<sup>4</sup>, and D. R. Zimmerman<sup>5</sup>, <sup>1</sup>University of Nebraska, Concord, <sup>2</sup>University of Illinois, Urbana, <sup>3</sup>University of Minnesota, Morris, <sup>4</sup>Michigan State University, East Lansing, <sup>5</sup>Iowa State University, Ames.

A cooperative study was conducted with 900 crossbred pigs (26.2 kg initial wt) at five research centers utilizing a total of 12 replicates per treatment to evaluate the effect of remixing the lightest pigs at a mean replicate wt of 70 kg into new pens on overall pig performance to slaughter. Treatments were 15 pigs/pen from initial wt to slaughter (15S), 20 pigs/pen from initial wt to 70 kg BW and then reduced to 15 pigs/pen to slaughter (20/15), and 15 pigs/pen from 70 kg mean replicate wt to slaughter comprised of the five lightest pigs from each of three 20/15 pens per replicate (15M). Space allocation was .56 m<sup>2</sup>/pig from 26 to 70 kg and .74 m<sup>2</sup>/pig thereafter. Diets contained 44 mg/kg tylosin to 70 kg followed by 22 mg/kg to slaughter. There was no effect ( $P>.1$ ) of treatment (15S vs 20/15) on performance prior to 70 kg. Least square means for ADG from reallocation to first pig removal for slaughter at 113 kg

were 932, 872, and 907 gm/d for the 20/15, 15M, and 15S treatments, respectively ( $P < .05$ ). ADF for the respective treatments ( $P < .01$ ) was 3.14, 2.89, and 3.05 kg/d. Neither gain:feed (.304, .304, and .295 for 20/15, 15M, and 15S, respectively) nor carcass % lean (52.6%) were affected by treatment ( $P > .1$ ). Comparing the mean of the 20/15 plus 15M treatment vs 15S, there were no differences detected ( $P > .1$ ) for gain, efficiency of gain, or carcass merit. These data suggest the removal and reallocation into a new social group of the lightest 25% of pigs within a pen was not effective in improving overall performance of finishing pigs versus maintaining pen integrity to slaughter.

**Key Words:** Pigs, Mixing, Grow-Finish

**8 Effect of fish oil supplementation on the young pig's immunological response to an endotoxin challenge.** J.A. Carroll<sup>\*1</sup>, K.L. Fritsche<sup>2</sup>, J.D. Spencer<sup>2</sup>, A.M. Gaines<sup>2</sup>, G.L. Allee<sup>2</sup>, R.L. Matteri<sup>1</sup>, H.G. Kattesh<sup>3</sup>, M.P. Roberts<sup>3</sup>, L.A. Beausang<sup>1</sup>, and M.E. Zannelli<sup>4</sup>, <sup>1</sup>ARS-USDA, Columbia, Missouri, <sup>2</sup>University of Missouri-Columbia, <sup>3</sup>University of Tennessee-Knoxville, <sup>4</sup>Pierce-Endogen, Inc., Woburn, MA.

The objective of the present study was to evaluate the potential immunological benefit of adding fish oil to the diet of weaned pigs. Twenty-four crossbred male pigs were weaned at  $18.7 \pm .13$  days of age and placed on a complex nursery diet containing 30% lactose and 7% plasma protein with 6% corn oil as the fat source (Cont,  $n=12$ ) or with 5% fish oil and 1% corn oil as the fat source (FO,  $n=12$ ) for a period of 15 days. Body weights did not differ ( $P > .78$ ) between the two dietary groups either at the beginning or end of the 15d feeding period. On d15 all pigs were non-surgically fitted with an indwelling jugular catheter. On d16 pigs received an i.v. injection of either saline ( $n=6$  pigs/dietary group) or lipopolysaccharide (LPS; 150 ug/kg body weight;  $n=6$ /dietary group) and blood samples were collected at 30-min intervals for a period of 5h. Serum was harvested and stored at 20C for analysis of cortisol (CS) and corticosteroid-binding globulin (CBG), and at 80C for analysis of tumor necrosis factor-alpha (TNF) and interferon gamma (IFN). There was no significant effect of diet on basal concentrations (Time 0) of any of the blood parameters analyzed. A time x treatment x diet interaction ( $P=.023$ ) was observed for serum CS such that those pigs which consumed the FO diet followed by LPS treatment had a reduced CS response as compared to the LPS treated pigs on the Cont diet. A time x treatment interaction ( $P=.0048$ ) was observed for serum CBG such that LPS treatment reduced circulating CBG as compared to the saline treated pigs. Time x treatment x diet interactions were also observed for serum concentrations of TNF ( $P=.084$ ) and IFN ( $P=.022$ ) such that both the TNF and IFN response to the LPS challenge was lower in those pigs receiving the FO diet as compared to the LPS treated pigs on the Cont diet. Overall, serum CS was negatively correlated with the CBG response ( $r = -.40$ ,  $P < .0001$ ), however, the strongest negative correlation was observed in the LPS treated pigs which consumed the FO diet ( $r = -.63$ ,  $P < .0001$ ). While further studies are needed in order to evaluate the immunologically beneficial effect of including fish oil in the nursery pig diet, the present study demonstrates that supplementation with fish oil does indeed alter the immunological response to an endotoxin challenge.

**Key Words:** Piglets, Fish oil, Cytokines

**9 Supplemental Vitamin C and Beta-glucan alter growth and the LPS-induced immunological response in young pigs.** C.A. McKee<sup>\*1</sup>, J.A. Carroll<sup>2</sup>, S.D. Eicher<sup>1</sup>, M.E. Zannelli<sup>3</sup>, L.A. Beausang<sup>3</sup>, and R.L. Matteri<sup>2</sup>, <sup>1</sup>Livestock Behavior Research Unit, ARS-USDA, West Lafayette, IN, <sup>2</sup>Animal Physiology Research Unit, ARS-USDA, Columbia, MO, <sup>3</sup>Pierce-Endogen, Woburn, MA.

The objective of the present study was to evaluate the potential benefit of supplementing the neonatal pig with Vitamin C (VC) and/or Beta-glucan (BG). Thirty-two crossbred pigs were selected at birth and assigned to one of four dietary treatment groups ( $n=8$ /group). Beginning on the day of birth, pigs received their respective treatments via an oral gavage on a daily basis until weaning at 2 wks of age. Dietary treatment groups included Control (Cont; no VC or BG), VC (75 ppm), BG (.312 g/kg body weight) and VC+BG (75 ppm and .312 g/kg body weight). After weaning, pigs were placed on a starter ration containing their respective dietary treatments for a 2wk period. Body weights were

recorded every 3d to adjust dietary treatment doses. On d14 postweaning, blood samples were collected at 30-min intervals for one hr followed by an i.v. injection of lipopolysaccharide (LPS; 150 ug/kg). Blood samples were collected at 30-min intervals for an additional 3-hr period following the LPS challenge. Blood samples were analyzed for serum cortisol (CS), ACTH and tumor necrosis factor-alpha (TNF). A time x treatment interaction ( $P=.0002$ ) was observed for body weight such that those pigs receiving the VC+BG had greater body weights than the Cont ( $P < .017$ ) and VC ( $P=.009$ ) pigs and the BG pigs tended to have greater body weights than the Cont ( $P=.09$ ) and the VC ( $P=.05$ ) pigs. There was no effect of dietary treatment ( $P > .26$ ) on basal ACTH, CS or TNF. There was also no effect ( $P > .86$ ) of dietary treatment on the ACTH response to the LPS challenge. However, there was a dietary treatment effect ( $P < .045$ ) on the CS response to the LPS challenge. The CS response was lower ( $P=.005$ ) in the VC group as compared to the Cont group, and the CS response tended ( $P < .09$ ) to be lower in the BG and VC+BG groups as compared to the Cont group. A time x dietary treatment effect ( $P < .028$ ) was observed for the TNF response to the LPS challenge which can be primarily attributed to the more rapid decline in serum TNF for the VC group. While additional investigations are needed to fully elucidate the potential immunological benefit of including various nutritional supplements in the young pigs diet, the present data demonstrate that the inclusion of VC and/or BG do indeed alter piglet growth and the response to an endotoxin challenge.

**Key Words:** Neonatal pigs, Vitamin C and Beta-glucan, Immune response

**10 Spring and summer investigation of verotoxin-producing *Escherichia coli* (VTEC) in grazing sheep previously infected with VTEC.** H. S. Hussein<sup>\*</sup>, B. H. Thran, and H. A. Glimp, *University of Nevada-Reno.*

Although sheep have never been implicated in an *Escherichia coli*-associated foodborne illness, previous research has shown that their harbor verotoxin-producing *E. coli* (VTEC), including O157:H7. Because of this, lamb, mutton, or their products share a food safety risk similar to that of beef. In most cases research has focused on specific characteristics (i.e., sorbitol negative and 4-methylumbelliferyl- $\beta$ -D-glucuronide [MUG] negative) usually associated with *E. coli* O157:H7. However, VTEC encompass numerous serotypes of *E. coli* and are not limited to sorbitol negative; MUG negative isolates. The objective of this study was to assess prevalence of VTEC in sheep grazing Great Basin range land over 6-months (spring and summer, 2000). Nineteen yearling (15-mo old) ewes (7/8 Merino; 1/8 Rambouillet) were selected at random from a large flock (>1000 ewes) at Rafter 7 Ranch (Yerington, NV). A total of 35 fecal samples were collected in both seasons and were subjected to tentative analysis. The ewes grazed desert range forages (Indian ricegrass [*Oryzopsis hymenoides*] and various shrubs including white sage [*Ceratoides lanata*], fourwing saltbush [*Atriplex canescens*], and big sagebrush [*Artemisia tridentata*]) during spring and were allowed to graze an irrigated pasture (fescue [*Festula arundinacea*] and white clover [*Trifolium repens*]) during the summer months. A total of 124 isolates from both collection periods were tested for verotoxicity and the results showed that VTEC were not detected during these two seasons. Previous testing of these ewes revealed the presence of three VTEC serogroups (O6, O91 and, O128). Thus, the lack of detecting VTEC during spring and summer supports the hypothesis that infection with VTEC is transient and varies with season.

**Key Words:** Verotoxin-producing *Escherichia coli*, Sheep

**11 Non-O157:H7 verotoxin-producing *Escherichia coli* in sheep grazing an irrigated pasture.** B. H. Thran<sup>\*</sup>, H. S. Hussein, and H. A. Glimp, *University of Nevada-Reno.*

In addition to *Escherichia coli* O157:H7, there are approximately 60 other verotoxin-producing *E. coli* (VTEC) serotypes that have been associated with human illnesses. Although sheep products have never been implicated in a foodborne illness outbreak, previous research has found that sheep harbor both O157:H7 and other VTEC at similar rates reported for cattle. The objective of this study was to assess prevalence of VTEC in sheep grazing an irrigated pasture during spring and summer, 2000. Twenty yearling (15-mo old) ewes (7/8 Merino; 1/8 Rambouillet) were selected at random from a large flock (>1000 ewes) at Rafter 7 Ranch (Yerington, NV). The ewes grazed fescue (*Festula arundinacea*) and white clover (*Trifolium repens*) pasture. A total of thirty-five fecal samples were rectally collected in March and July. Initial isolates (n

= 100) were selected by using microbiological methods (lack of sorbitol fermentation and metabolism of 4-methylumbelliferyl- $\beta$ -D-glucuronide [MUG]). Due to the large numbers of bacteria that are present in ovine fecal samples, we limited initial isolates for screening to sorbitol negative colonies because classic O157:H7 demonstrates this characteristic. To increase the probability of detecting sorbitol negative non-O157:H7 VTEC, we did not limit our selection to MUG negative isolates (a second unique characteristic of O157:H7). Verotoxin tests were performed to determine the toxicity status of the isolates. Eleven verotoxin isolates were detected in five fecal samples in March while two verotoxin isolates were detected in July from one ewe that was also positive in March. The verotoxin isolates were confirmed as *E. coli* by the API identification system. Polymerase chain reaction and reversed phase latex agglutination were performed to confirm the presence and expression of the verotoxin genes (VT1 and VT2). Seven VTEC isolates had and expressed only the VT2 gene while the remaining 6 VTEC isolates had and expressed both VT1 and VT2 genes. Ten VTEC isolates were serotyped as O91:NM (non-motile) while three VTEC isolates were O128:NM. Both serotypes have previously been isolated from healthy sheep and were associated with bloody diarrhea or hemolytic uremic syndrome in humans. Therefore, it may be important to screen sheep for the presence of VTEC before slaughter to decrease the risk of contamination of lamb or mutton with VTEC.

**Key Words:** Verotoxin-Producing *Escherichia coli*, Sheep

## 12 Subcutaneously injected glucagon affects selected blood constituents in dairy cows. B. N. Ametaj\*<sup>1</sup>, G. Bobe<sup>1</sup>, S.L. Oren<sup>1</sup>, O. Rosendo<sup>2</sup>, D. C. Beitz<sup>1</sup>, and J. W. Young<sup>1</sup>, <sup>1</sup>Iowa State University, <sup>2</sup>University of Florida.

Up to fifty percent of dairy cows develop mild to severe fatty liver during the periparturition period. This disorder can lead to increased incidences of other conditions such as ketosis, mastitis, metritis, and reproductive failures. Previously, we reported that intravenous infusion of glucagon at 10 mg/d for 14 d improves the lipid and carbohydrate status of fatty livers in dairy cows. To develop practical ways to deliver glucagon for treatment or prevention of fatty liver, four Holstein mid-lactating cows were injected subcutaneously with both 2.5 and 5.0 mg of glucagon in a balanced cross-over design. Blood samples were taken from indwelling jugular vein catheters and analyzed for concentrations of glucagon, glucose, insulin, and non-esterified fatty acids (NEFA) in plasma. Plasma insulin, glucagon, and glucose were increased for 2, 4, and 5 h, respectively, after injections of both glucagon dosages ( $P < 0.05$ ). Neither dosage increased concentrations of NEFA in plasma. In fact, plasma NEFA concentrations were decreased by both dosages for 4 h after injection ( $P < 0.05$ ). The results of this study indicate that injection of glucagon subcutaneously is a safe and effective way of delivering glucagon to dairy cows. (Partly supported under CSREES-USDA agreement 99-35004-8576)

**Key Words:** glucagon, subcutaneous, blood variables

## BREEDING AND GENETICS

### 13 Reproductive performance of Ohio dairy herds in the 1990's: Preliminary, descriptive results. P.J. Rajala-Schultz\*<sup>1</sup> and G.S. Frazer<sup>1</sup>, <sup>1</sup>The Ohio State University, Columbus, Ohio.

Reproductive performance of a dairy herd can directly and indirectly affect the profits of a farm in several ways. Reproductive inefficiency reduces the amount of milk produced per cow per day and number of calves born per year. It can add labor expenses as well as veterinary and treatment costs. Also, involuntary culling subsequent to reproductive failure increases replacement costs. The purpose of this study was to evaluate reproductive performance of Ohio dairy herds in the 1990's. The data came from farms belonging to Ohio Dairy Herd Improvement (DHI) Cooperative Inc. Only farms with at least 20 cows and average herd milk production at least 10,000 lbs were included in the analysis. Farms with extremely high culling percentage (over 80) in any given year were also excluded from the data set. Also, in attempt to ensure high data quality with consistent data recording, each farm was expected to have at least 10 DHI tests each year to be included in the analysis. The number of farms has decreased in Ohio during the 1990's. After applying the above exclusion criteria, our data set declined from 1645 herds in 1992 to 1011 herds in 1998. In 1992, 37.1 % of the farms had fewer than 50 cows and 2.9 % of the farms had more than 200 cows, while the respective percentages in 1998 were 30.0 and 5.2 %. The proportion of farms with 101 to 200 cows increased from 13.6 % in 1992 to 21.1 % in 1998. Average herd milk production increased from 17,782 lbs in 1992 to 19,117 lbs in 1998. Data was checked for illogical values with respect to reproductive indices. For example, herds with average days open less than 60 were excluded. Farms not recording services (most likely using natural service) were also excluded from the analysis. The preliminary results show a slight declining trend in reproductive performance during the past decade. Calving interval lengthened from 13.6 months in 1992 to 14.1 months in 1998 and the average number of days open increased from 136 in 1992 to 151 days in 1998. At the same time, number of days in milk at first service increased from 91 days to 94 days. All these parameters steadily increased through the 1990's. Number of services per conception was 1.83 in 1992, 1.84 in 1994 and then increased to 1.93 in 1996 and 1998.

**Key Words:** Reproductive performance, Ohio dairy herds

### 14 Genetic evaluation of fertility in US Holstein cattle. K. A. Weigel\*<sup>1</sup>, <sup>1</sup>University of Wisconsin, Madison.

Our objective was to evaluate the potential for national genetic evaluations for service bull (male) and daughter (female) fertility in US Holstein cattle. Data included 8.03 million insemination records from 1995

to present. Up to eight services per cow per lactation were used. The US was divided into nine geographical regions based on data from the National Climate Data Center. Mean 70 day non-return rate (NR70) ranged from 0.47 in the Southwest to 0.57 in the Midwest. Mean NR70 decreased from 0.55 for first services to 0.47 for sixth and seventh services. Mean service bull fertility for commercial AI studs ranged from 0.47 to 0.56, and differences between studs were consistent across geographical regions. Data were analyzed using a normal linear model that included fixed effects of region-year-month, parity by age of calving, service number by days in milk, and age of service bull by region. Random effects included herd-year-season, service bull, service bull by herd, animal (with relationships), and permanent environment. A significant birth year trend was observed for service bull fertility when age of bull at the time of insemination was ignored. Solutions for proven bulls were biased upward, and solutions for young sires were biased downward, because differences exist in the way that farmers use (expensive) proven sire semen versus (inexpensive) young sire semen. Bias was reduced by considering age of bull, and this adjustment was particularly effective when age of bull by region interactions were modeled. In practice, it is likely that an age of bull by herd interaction would probably be most effective. The range in service bull solutions for bulls with at least 100 inseminations was 15%, and the range in daughter fertility breeding values for sires with at least 100 progeny was 24%. Correlations between independent estimates from odd- and even-numbered herds were 0.88 for both male and female fertility. Correlations between daughter fertility breeding values and predicted transmitting abilities for milk yield were -0.10, indicating that it should be possible to find individual bulls that sire efficient milk production and superior daughter fertility.

**Key Words:** fertility, Holstein, genetic

### 15 Genetic evaluation of dairy cattle using test-day models. J. Jensen\*, Danish Institute of Agricultural Sciences.

Recently there have been considerable interest in modeling individual test-day records (TDR) for genetic evaluation of dairy cattle in stead of the traditional use of estimated accumulated 305 d yields. The purpose to this presentation is to review the use of test-day models for genetic evaluation of dairy cattle.

Some advantages of test-day models (TDM) are a better ability to account for environmental effects of each test day, the ability to model the trajectory of the lactation for individual genotypes or for groups of animals and the possibility of predicting genetic evaluations for persistency of production. Also the use of test day models avoids the necessity of extending short lactations on culled animals and on recent animals with records in progress. Disadvantages of TDM are the necessity of analyzing much larger sets of data and the need to estimate many more

parameters when comparing to the traditional 305 d lactation model. Several different models have been proposed to model the trajectory of the lactation, including so-called "biological functions", various polynomials and character process models. So far there is no universal agreement on which models to use in practical prediction of breeding values. Better methods to compare different models is desirable. Obtaining accurate estimates of the dispersion parameters to use in TDM remains a challenge. Methods used range from a two step procedure where the dispersion parameters are estimated in multivariate models followed by a reduction in order of fit using covariance functions, to direct estimation of the parameters in the TDM using restricted maximum likelihood or Bayesian methods. Further research is needed to find better ways to include multiple lactation data and to take heterogeneous variance into account.

**Key Words:** Dairy cattle, Test day models

## 16 Methods to categorize patterns of elevated test day somatic cell score. X. Li, M. M. Schutz\*, and A. P. Schinckel, *Purdue University, West Lafayette, IN.*

Periods of elevated SCS may be under different levels of genetic control related to their cause and duration. The goal of this project was to determine whether patterns of test day (TD) SCS can be used to distinguish between short and chronic episodes of mastitis. Data consisted of TD SCS of Holsteins used in USDA genetic evaluations. Following edits, 14465014 TD records in 1630195 lactations of 1183812 cows in 29370 herds were available. Two methods were evaluated to categorize elevated TD SCS. The first method (M1) used comparison to a threshold SCS value of 5 because higher SCS are usually considered indicative of clinical mastitis. Consecutive TD SCS were compared. If TD SCS increased by more than 2 scores to greater than 5 and then decreased by 2 scores to below 5, an episode of short duration (SH) was indicated. If the score remained above 5 or declined by less than 2 scores, an episode of long duration (LO) was indicated. The second method (M2) used residuals to identify episodes of elevated SCS. A fifth degree polynomial model was chosen to represent the lactation curve for TD SCS. Observed values of each TD SCS within a lactation were compared to predicted values for herd. SH was indicated whenever observed values were more than 1 residual SD (RSD) greater than predicted values and LO was defined as consecutive TD residuals of more than 1 RSD, where RSD corresponded to each of thirty stage of lactation classes when fitting the lactation curve by parity within herd. SH were indicated for 2.1% (M1) and 3.5% (M2) of all TDs and 17.0% (M1) and 26.3% (M2) of all lactations. LO were indicated for 5.5% (M1) and 7.5% (M2) of all TDs and 17.0% (M1) and 22.5% (M2) of all lactations. SH was indicated for 1.5% of TD and 13.1% of lactations and LO was indicated for 4.9% of TD and 15.9% of lactations by both methods. The predicted incidences of SH and LO increased with parity, likely due to the higher incidence of mastitis in later lactations. Results imply that some differences between environmental and chronic mastitis may be accounted by differences in patterns of TD SCS.

**Key Words:** Somatic Cell Scores, Mastitis, Lactation Curves

## 17 Identification of genetic markers associated with production and health traits in Holstein cattle using single and multiple trait analyses. A. B. Kurtz\*, S. L. Rodriguez-Zas, D. W. Heyen, and H. A. Lewin, *University of Illinois at Urbana-Champaign.*

Single and multiple trait analyses of daughter yield deviations for milk, fat, and protein yield and somatic cell score were undertaken to identify genetic markers associated with these traits. Data on eight US Holstein grandsire families in a granddaughter design were studied. A total of 1065 sons were screened for 174 microsatellite markers across all autosomes. The number of informative markers per chromosome ranged from one to eight. A least squares analysis was performed with weights equal to the variance of the trait. Genome-wide critical p-values were calculated using a Bonferroni correction to account for multiple testing and for the multiple traits. Two markers, 13.3 cM apart, on chromosome 14 were associated with significant variation in milk and fat yield. The first marker (ILSTS39) had significant effects on milk and fat yield ( $P < 0.0001$ ) and the second marker (CSSM66) had a significant effect ( $P < 0.001$ ) on fat yield. While increases in milk and fat yield were associated with an ILSTS39 allele in one family, the same allele was associated with a decrease in milk yield and an increase in fat yield in

another family, showing inconsistent allelic associations across families. These results support previous findings based on single marker analyses. Both markers were also significant ( $P < 0.001$ ) in a multiple trait analysis, suggesting the possibility of a QTL with pleiotropic effects on milk and fat yield. In addition, two markers, one located at 61 cM on chromosome 1 and the other at 31.8 cM on chromosome 3, were significant ( $P < 0.001$ ) in multiple trait analyses but were non-significant in the single trait analyses. Multiple trait analysis allows the identification of putative QTL pleiotropic effects and accounts for the correlation between traits that may uncover markers found to be non-significant in a single trait analysis.

**Key Words:** Multivariate Analysis, Single Marker Analysis, Pleiotropy

## 18 Genetic evaluation using finite locus models. L.R. Totir\*<sup>1</sup>, R.L. Fernando<sup>1</sup>, S.A. Fernandez<sup>1</sup>, and B.R. Southey<sup>2</sup>, <sup>1</sup>*Iowa State University, Ames, Iowa*, <sup>2</sup>*University of Illinois, Urbana, Illinois.*

Increased availability of genotypes at marker loci has prompted the development of models that include the effect of individual genes. Selection based on these models is known as marker assisted selection (MAS). MAS is known to be efficient especially for traits that have low heritability. However gene action in such traits is known to be non-additive. BLUP methodology under non-additive gene action is not feasible for large pedigrees. Use of multibreed data further increases the complexity of the problem. It is easy to incorporate non-additive gene action in a finite locus model. Given a finite locus model, Markov Chain Monte Carlo (MCMC) methods can be used for genetic evaluation with large and complex pedigrees. Furthermore, multibreed data do not add to the complexity of the problem. In order to investigate the feasibility of MCMC methods for genetic evaluation, the scalar Gibbs sampler was used to compute the conditional mean of the genotype given the phenotype for finite locus models when all parameters are known. For simple pedigrees, the exact values of the conditional mean can be calculated using the Elston-Stewart algorithm. The conditional means obtained using the scalar Gibbs sampler for models with one, two, and three loci were compared to the exact values calculated using the Elston-Stewart algorithm. For pedigrees where individuals have a small number of offspring, genetic evaluations obtained using scalar Gibbs were within Monte Carlo error from the exact values for all models considered. For pedigrees where individuals have a large number of offspring, slow mixing was observed regardless of the number of loci in the model. Blocking Gibbs, where genotypes are sampled in blocks, has been proposed as an alternative to overcome this problem. This approach has been extended to sample genotypes jointly from the entire pedigree. An MCMC sampler, known as ESIP, combines the Elston-Stewart algorithm with iterative peeling to obtain joint samples from the entire pedigree, which are then accepted or rejected by the Metropolis Hastings algorithm. The problems encountered with scalar Gibbs seem to disappear when ESIP is used.

**Key Words:** Finite locus model, Markov Chain Monte Carlo, Non-additive gene action

## 19 Statistical models and tests for detecting imprinted genes in QTL scans. H.K. Lee<sup>1</sup>, J.C.M. Dekkers\*<sup>2</sup>, R.L. Fernando<sup>2</sup>, and M.F. Rothschild<sup>2</sup>, <sup>1</sup>*National Livestock Research Institute, South Korea*, <sup>2</sup>*Iowa State University, Ames, IA.*

De Koning et al. (PNAS, 2000) detected gametic imprinting for QTL in a swine F2 cross based on a comparison of levels of significance of paternal and maternal imprinting effects against a no-QTL model. They did not test imprinting against a Mendelian model, which is needed to identify deviations from Mendelian inheritance. The objective of this study was to develop such tests. Phenotypes on 2 traits (last rib back fat and marbling) and genotypes from 7 markers on chromosome 1 from 525 F2's from a swine breed cross were used. Analyses were based on line cross regression interval mapping using the following QTL models: Mendelian (additive and dominance effects), full imprinting (separate maternal and paternal allele effects plus dominance), and paternal (no maternal and dominance effects) and maternal imprinting. Each model was tested against the no-QTL model and the full imprinting model was tested against the Mendelian and paternal and maternal imprinting models. Chromosome-wise 5% significance thresholds were derived from 10,000 data permutations. For tests against the Mendelian model paternal and maternal coefficients were permuted within individual. For tests against the paternal (maternal) imprinting model the sign of the

maternal (paternal) and dominance coefficients were randomly changed. Thresholds against the no-QTL model for the two traits were 5.1 and 5.0 for the Mendelian model, 4.1 and 4.0 for full imprinting, and 7.2 and 7.1 for maternal or paternal imprinting. Thresholds for full imprinting were 4.6 and 4.0 against the Mendelian model, and 3.2 and 3.8 against maternal or paternal imprinting. In our data, backfat showed significant QTL at similar positions under the Mendelian and full and paternal imprinting models. Full imprinting was significant over Mendelian inheritance but not over paternal imprinting, indicating a paternally expressed QTL. Marbling showed significant QTL under all models but imprinting was not significant over Mendelian inheritance. The models and tests developed in this study allow detection and evaluation of imprinted QTL.

**Key Words:** QTL mapping, Gametic imprinting, Swine

## 20 Computer simulation comparison of Least Squares Lehmann-Scheffe and REML estimation of variance components. W.D. Slanger\*<sup>1</sup> and J.W. Carlson<sup>1</sup>, North Dakota State University.

Research objective was to compare Least Squares Lehmann-Scheffe estimators (Slanger, 1996) of two variance components and heritability with those of REML. Model was fixed herd by random sire with interaction. 39 progeny were distributed over 3 herds and 4 sires. There were 15,000 computer simulation replications per each of 96 combinations of designs (n=6), heritabilities (.05, .20, .50, .70), ratios of sire variance to interaction variance (3:1, 1:3), and distributions (normal and chi-square with 3 df). The designs ranged from almost balanced to very unbalanced. Nonzero estimates of variance components and heritability were used in the LSLs vs. REML comparisons. Results for the normal distribution are presented since normal and chi-square results were close for all 96 combinations. LSLs was superior to REML, and the more unbalanced the design the more superior was LSLs. The results here are for the most unbalanced design for which there was one subcell with no progeny for each of the four sires and there were large variations within both row and column totals. Percentages of nonzero estimates were always greater of LSLs. Averaged over the eight parameter combinations, LSLs produced 29, 39, and 142% more nonzero estimates of sire variance, interaction variance, and heritability, respectively. Analogous average ratios of REML mean square errors to LSLs mean square errors were 7.32, 1.75, and 3.57. Estimator variances and biases were always lower for LSLs. Distributions of LSLs estimators were superior in that the percentages of estimates within plus and minus 50% the value of the parameter were always greater for LSLs than REML. Averaged over the eight parameter combinations, 68, 18, and 50% more LSLs estimates were within plus and minus 50% of the value of the parameter than REML estimates of sire variance, interaction variance, and heritability, respectively. Results were the same whether the variance ratio was 3:1 or 1:3. Results are substantive evidence that LSLs is superior to or at least competitive with REML for estimating variance components and heritability and justify efforts to make the LSLs procedure computationally efficient.

**Key Words:** REML, Heritability, Estimation

## 21 Mapping microsatellite markers identified in porcine EST sequences. G. A. Rohrer\*<sup>1</sup>, S. C. Fahrenkrug<sup>1</sup>, N. Tao<sup>2</sup>, and W. C. Warren<sup>2</sup>, <sup>1</sup>USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE USA, <sup>2</sup>Monsanto Co., St. Louis, MO USA.

A recent focus of swine genomics research has been to sequence a significant number of the genes which are expressed in the pig. The most popular approach to accomplish this goal is to collect single-pass sequence data from cDNA clones. The sequence data obtained, often between 400 and 600 bases in length, are called expressed sequence tags (EST). A sequence search of these data in GenBank and the MARC swine EST data identified over 100 sequence files which contained a microsatellite repeat. Most repeat motifs detected were dinucleotide (CA/GT) repeats; however, a number of tri-, tetra-, penta- and hexa-nucleotide repeats were also detected. The selection criteria for testing a microsatellite marker was that it span more than 18 bases of uninterrupted sequence. There was a considerable level of redundancy in the sequences identified and some files did not contain enough data adjacent to the microsatellite repeat to yield useful primers for amplification. Fifty-eight pair of primers were ordered representing 44 di-, 7 tri-, 1 tetra-, 1 penta-, and 4 hexa-nucleotide repeats, as well as 1 compound (contained a di-

tri- and tetra-nucleotide repeat) repeat motif. Thirty-four markers were polymorphic in the MARC reference population, 13 markers were uninformative and 11 primer pairs failed to satisfactorily amplify genomic DNA. A comparison of di-nucleotide repeat versus markers with repeat motifs of 3-6 bases determined that 73% of the di-nucleotide markers were useful relative to only 8% for the other repeat motifs. The difference was due to a much higher percentage of monomorphic markers in the 3-6 base repeat motif markers than in the di-nucleotide markers (69% vs 9%). Either the higher order repeat motifs are less polymorphic in the porcine genome or our selection criteria was too low. The percentage of monomorphic di-nucleotide markers was slightly higher, and the rate of unsatisfactory amplification was double that observed when di-nucleotide markers were derived from genomic sequence. This increased amplification failure rate could be due to the presence of introns between primer sites or base calling errors in the EST sequence files. Nonetheless, the mapped markers not only add useful microsatellites to the porcine genetic map but they also provide valuable links between the porcine and human genome.

**Key Words:** Porcine, EST, Microsatellite

## 22 Mapping expressed sequence tags (ESTs) in pigs using single nucleotide polymorphisms (SNPs). B. A. Freking\*, S. C. Fahrenkrug, G. A. Rohrer, T. P. L. Smith, and J. W. Keele, Roman L. Hruska U.S. Meat Animal Research Center.

A high density type-I marker map allows rapid identification of segments of the human genome map orthologous to porcine segments harboring economically relevant loci. Existing swine genetic linkage maps have been used to scan the porcine genome for chromosomal regions that affect economically important traits, but these maps lack power for comparative mapping efforts targeted to specific regions. Our objective is to directly integrate sequence variability associated with ESTs into the existing genetic map. Bovine and porcine ESTs obtained from clones derived from mixed-tissue normalized cDNA libraries were subjected to an automated primer design process to produce a product flanking a predicted intron region. Primers were designed if EST sequence matched a mapped human orthologous sequence with genomic sequence data to predict position of introns. Successful porcine genomic amplification products (n=264 unique loci) were sequenced and screened for SNPs in a total of 16 animals. Nine of these animals were parents of the MARC swine reference population. A total of 948 SNPs were identified. Sequencing revealed an average of 7.4 heterozygous animals per amplicon. Based on sequence data, an average of 74 informative meioses per amplicon are generated by genotyping the reference population for the available SNP. Genotyping assays were designed to utilize the MALDI-TOF detection coupled microsequencing approach. A total of 93 amplicons have assays designed for 167 individual porcine SNPs. Genotyping has been completed on the MARC swine reference population for 50 of these assays. Genotypic data from these SNP assays allows confirmation of segregation of the SNPs and provides map location of EST associated marker loci directly on the existing genetic map. High-throughput genotyping systems which utilize SNP-based markers would be enhanced by prior knowledge of position and informativity of SNPs in various populations to ensure genomic coverage.

**Key Words:** Swine, Mapping, Single Nucleotide Polymorphisms

## 23 Comparative Mapping of the Porcine X Chromosome. S. A. McCoard\*, S. C. Fahrenkrug, B. A. Freking, G. A. Rohrer, T. H. Wise, and J. J. Ford<sup>5</sup>, USDA, ARS, RLH US Meat Animal Research Center.

Porcine chromosome X (SSCX) harbors QTL influencing testicular size and elevated FSH levels. Testicular size establishes the upper limit for total daily sperm production and thereby affects financial returns of boar studs. These QTL were identified using primarily anonymous microsatellite markers that give little insight into the identification of the genetic basis of these phenotypes. In order to take maximal advantage of human-pig comparative mapping strategies for positional candidate gene cloning, a detailed comparative map employing gene-linked markers is required. Therefore, the objective of this study was to develop an integrated map of SSCX using both microsatellite and gene-linked markers. Gene-linked markers were developed from porcine ESTs generated from either the MARCP1G1 (11, 13, 15, 20, and 30-day-old pig embryos) or MARCP1G2 (ovary, testis, hypothalamus, pituitary, endometrium and placenta) normalized cDNA libraries. BLAST analysis confirmed that

these markers were orthologous to genes known to reside on the human X chromosome (HSAX). A physical map of SSCX was constructed using 54 markers typed onto the T43 radiation hybrid (RH) panel (Research Genetics), and a LOD of >10 was the minimum criteria for linkage using the software package RHMAPPERv1.22. The markers included 33 microsatellite and 21 gene-linked markers. In addition, 23 gene-linked markers were amplified from the MARC reference population, and found by DNA sequencing to contain single nucleotide polymorphisms (SNPs) suitable for genetic mapping. SNPs were discovered in 20 gene-linked markers, 13 of which were also mapped by RH analysis. Analysis of our integrated comparative map of SSCX supports a striking conservation of synteny between SSCX and HSAX. This integrated map will be valuable for the selection of candidate genes for pig reproductive QTL mapped to the porcine X chromosome.

**Key Words:** Follicle-Stimulating Hormone, Radiation Hybrid Panel, Testes

#### 24 Effect of boar exposure during insemination on factors influencing fertility in gilts. K.L. Willenburg<sup>\*1</sup>, G.M. Miller<sup>1</sup>, and R.V. Knox<sup>1</sup>, <sup>1</sup>University of Illinois, Urbana, IL.

The experiment tested for the effects of boar exposure and back-pressure during artificial insemination (AI) on semen backflow and embryo quality. Prepubertal gilts (165 d) were given PG600 followed by hCG 72 h later. Fenceline estrous detection was performed in pens every 12 h beginning 24 h after hCG. At estrus, gilts were allotted to receive boar exposure (BE; n=15) or no boar exposure (NB; n=17). Insemination occurred in crates at 12 and 24 h after onset of estrus with  $3 \times 10^9$  sperm/80 mL in Modena extender. Uteri were flushed 2 d after AI to evaluate fertilization, accessory sperm, and embryos. Average duration of AI was  $3.5 \pm 0.2$  min but was not influenced by BE ( $P > 0.1$ ). Backflow of semen was collected at 0 (LK0), 15 (LK15), 30 (LK30), 45 (LK45), 60 (LK60), 120 (LK120), 240 (LK240), and 480 (LK480) min after insemination. At LK0 (during AI) BE allowed less leakage ( $18$  vs  $32 \pm 3$  mL) and less sperm loss ( $0.8$  vs  $1.4 \pm 0.15 \times 10^9$  sperm) compared to NB ( $P < 0.01$ ). This accounted for a 5% reduction in volume lost and a 19% advantage in sperm inseminated. At LK15 an average of  $12 \pm 2$  mL was leaked but was not influenced by BE. However a treatment by time effect was observed ( $P < .01$ ). At LK30 ( $11.2$  vs  $5.9 \pm 1$  mL) and LK45 ( $9.0$  vs  $3.5 \pm 1$  mL) leakage was greater for BE than NB, respectively. By LK45, total volume leaked ( $52$  vs  $54 \pm 1$  mL) and sperm lost ( $1.6$  vs  $1.9 \pm 0.03 \times 10^9$ ) was not different ( $P > 0.1$ ) between BE and NB. Volume and sperm lost from LK60 to LK480 did not differ. By 8 h, total leakage ( $65$  vs  $64$  mL) and total sperm lost ( $1.7 \times 10^9$  vs  $1.9 \times 10^9$ ) was not influenced by BE ( $P > 0.1$ ). The percentages of pregnant gilts (97%), embryos (11.8), and accessory sperm per egg (7) were not influenced by BE ( $P > 0.1$ ). However, ease of insemination of gilts from BE was noted. There was no effect of treatment on any measured parameter between first or second AI. It was concluded that the sperm concentration used masked the effects of NB and that total leakage was proportional to the volume lost at time of AI, which did not effect fertility.

**Key Words:** Artificial insemination, Gilt, Boar

#### 25 Reproductive responses in the NE Index line estimated in pure line and crossbred litters. D. Petry<sup>\*1</sup> and R. Johnson<sup>1</sup>, <sup>1</sup>University of Nebraska.

The objective was to estimate responses in reproductive traits in the NE Index line (I) that was selected 18 generations for increased litter size. Responses were compared in pure line, F1 and 3-way cross litters. A total of 763 litters were produced in 5 year-seasons including two with 2nd parity sows. There were 224 line I and control line (C) litters, 350 F1 litters produced from I and C females mated to Danbred<sup>TM</sup> Landrace (L) or DH boars, and 189 litters by IxL and CxL females mated to DH boars. Contrasts of means were used to estimate the genetic difference between I and C and interactions of line differences with mating type. Farrowing rate of lines I ( $\hat{u} = 89.7\%$ ) and C ( $\hat{u} = 92.1\%$ ) did not differ, nor did F1 females ( $\hat{u} = 94\%$ ) differ from pure line females. Mean number born alive per litter and number and weight of pigs weaned per litter, both adjusted for number nursed and weaning age of 12.0 d, were 11.0 pigs, 9.8 pigs, and 33.1 kg, respectively. Direct genetic effects of I were greater ( $P < .01$ ) than C for total born (3.86 pigs), number born alive (2.57 pigs), number of mummified pigs (.28 pigs), and litter birth weight (1.77 kg). Line I was less than C ( $P < .01$ ) for number weaned (-.43 pigs) and litter weaning weight ( $\pm 1.21$  kg). However, interactions

of line effects with crossing system were significant. In pure line litters, I exceeded C by 4.66 total pigs per litter, 2.5 live pigs, and .27 mummified pigs; whereas the estimate of  $I \pm C$  in F1 and 3-way cross litters was 2.61 total born, 1.89 born alive, and .21 mummified pigs. The difference between I and C in pure line litters was -.86 pigs weaned, and 2.95 kg litter weaning weight, compared with -.33 pigs and -.49 kg in F1 and 3-way cross litters. F1 females with 3-way cross litters had .94 more total pigs, 1.49 more live pigs, 5.05 kg greater litter birth weight, .78 more pigs weaned, and 9.39 kg greater litter weaning weight than the average of I and C litters. Crossbreeding is an effective way to utilize the enhanced reproductive efficiency of the Index line.

**Key Words:** Reproduction, Selection, Crossbreeding

#### 26 Pregnancy diagnosis in swine: a comparison between transrectal and transabdominal real-time ultrasound. G.M. Miller<sup>\*1</sup>, K.L. Willenburg<sup>1</sup>, and R.V. Knox<sup>1</sup>, <sup>1</sup>University of Illinois, Urbana, IL.

This experiment determined if transrectal ultrasound (tRTU) was advantageous for diagnosing early pregnancy compared to transabdominal ultrasound (aRTU). Sows (n=97) were examined in crates at 16, 18, 20, 22 and 24 d after the first insemination. An Aloka 500V ultrasound fitted with a 7.5 MHz linear-array transducer was used for tRTU examinations while a 3.5 MHz convex-array transducer was used for aRTU. Time to diagnose animals as pregnant, not pregnant or undecided was recorded. Criteria for diagnosis of pregnant was multiple clear fluid pockets in the uterus with a diameter >1 cm. Diagnoses prior to d 20 could be made on only two animals when using specified criteria. However, more animals were diagnosed with tRTU on d 20 (71 vs 2 %) and 22 (98 vs 53 %) compared to aRTU ( $P < .01$ ). By d 24 there was no difference between the animals diagnosed (100 vs 93 %). Time to make a decision for tRTU ( $2.1 \pm .1$  min) was greater ( $P < .01$ ) than aRTU ( $.6 \pm .1$  min). Accuracy (correct diagnoses/total diagnoses) for tRTU on d 20, 22 and 24 was 93% (n=69), 94% (n=95) and 95% (n=97) respectively and accuracy for aRTU was 50% (n=2), 90% (n=51) and 90% (n=90). Specificity (correct not pregnant/total not pregnant) for tRTU on d 20, 22 and 24 was 54.5% (n=11), 60% (n=15) and 71% (n=17). Specificity for aRTU was 60% (n=5) on d 22 and 38.5% (n=13) on d 24. On d 20, not pregnant diagnoses were not obtained. Sensitivity (correct pregnant diagnoses/total pregnant) was 100% on d 20 and 22 for both tRTU (n=58, n=80) and aRTU (n=1, n=46). On d 24, sensitivity was 99% for both tRTU (n=80) and aRTU (n=77). Accuracy, specificity and sensitivity were not statistically different between methods. From d 18 to 24, CL diameter decreased significantly ( $P < .01$ ) from 0.99 cm to 0.87 cm. From d 18 to 24, uterine fluid diameter increased significantly by day ( $P < .01$ ) from 0.84 cm to 3.75 cm. In conclusion, tRTU required more time to diagnose animals but due to resolution allowed diagnosis earlier and made it possible to view ovaries, the conceptus and uterus.

**Key Words:** real-time ultrasound, pregnancy, sows

#### 27 Methods for editing and adjusting feed intake data from electronic swine feeders. D.S. Casey<sup>\*1</sup> and J.C.M. Dekkers<sup>1</sup>, <sup>1</sup>Iowa State University, Ames, Iowa.

Electronic feeders are used to record feed intake in group-housed pigs by recording trough weight and time at the beginning and ending of every visit. Resulting data are subject to numerous equipment- and animal-related errors. The objectives of this study were to identify errors in data from electronic feeders, to estimate the effects these errors have on recorded feed intake, and to adjust feed intake records for errors. Data from FIRE<sup>TM</sup> feeders from 591 crossbred pigs from the National Pork Producers Council's Maternal Line Genetic Evaluation Program were used. Sixteen algorithms were used to identify errors in each visit, of which nine were modified from Eissen et al. (1998, Appl. Eng. Agric. 14(6): 667). Feed intake per pig per day (FID) from visits with no errors was used as the dependant variable in a linear model that was fit to estimate the effect of errors on FID and to adjust FID. Breed (6), sex (2), replicate (2), and week within replicate (25) were fit as fixed effects, pig as a random effect, and estimated weight and average daily gain as covariates. To account for the impact of errors, for each FID percentages of visits with each error type, occupation times from visits with each of 11 error types, and recorded feed intakes from visits with each of 4 error types were fit as covariates. Of the 460,910 total visits, 37.1% were unidentified (85.1% of these had <20g intakes). Of the identified visits, 5.6% contained errors and less than 1% contained

a given error type. Of the 44,981 records for FID, 17.2% contained at least one visit with an error. Thirteen of the 16 percent error effects, 10 of 11 occupation time effects, and 2 of 4 feed intake effects were statistically significant ( $P < .10$ ). Model estimates were used to adjust FID for errors. The correlation of adjusted FID with FID was .928. These results indicate that feed intake data from electronic swine feeders must be edited and that the estimates from a linear model can be used to adjust observed records for errors. The National Pork Producers Council is acknowledged for provision of data.

**Key Words:** Swine, Feed Intake, Editing

**28 Growth and carcass responses in the NE Index line estimated in pure line and crossbred litters.** D. Petry<sup>\*1</sup>, J. Holl<sup>2</sup>, and R. Johnson<sup>1</sup>, <sup>1</sup>University of Nebraska, <sup>2</sup>North Carolina State University.

The objective was to estimate responses in growth and carcass traits in the NE Index line (I) that was selected 18 generations for increased litter size. Responses were compared in pure line, F1 and 3-way cross litters. In Exp 1, 492 gilts that were retained for breeding, including 323 line I and control (C) and 169 F1 I and C by Danbred<sup>TM</sup> Landrace (L), were evaluated. Contrasts of means were used to estimate the genetic difference between I and C and interactions of line differences with mating type. Mean backfat, loin eye area and age, adjusted to weight of 88.2 kg, were 2.05 cm, 30.54 cm<sup>2</sup> and 193 d, respectively. Direct genetic effects of I and C did not differ for backfat, loin eye area or age, and interaction of estimates of direct effects with mating type were not significant. F1 gilts had -.32 cm less backfat, 4.9 cm<sup>2</sup> greater loin eye area and 30 d less to 88.2 kg than I and C gilts ( $P < .01$ ). Exp 2 used individually penned barrows and gilts including 22 I and C, 55 F1 produced from I and C females mated to (L) or Danbred<sup>TM</sup> DH boars, and 54 3-way crosses produced from LxL and CxL females mated to DH boars. Direct genetic effects of I were greater ( $P < .01$ ) than C for adfi (.28 kg) but effects for f/g (.08 kg) and adg (.08 kg) were not significant. Interactions of line effects with crossing system were not significant for growth traits. F1 and 3-way pigs had .20 kg/d greater adfi, -.55 less f/g and .17 kg/d more adg than I and C. Mean backfat, loin eye area, TOBEC lean, Minolta color score and pH, adjusted to weight of 112.7 kg, were 2.47 cm, 40.1 cm<sup>2</sup>, 48.1%, 47.7 Minolta score and 5.59 pH units, respectively. Lines did not differ in direct genetic effects on carcass traits and interactions of line effects with crossing system were not significant. F1 and 3-way crosses had 1.13 cm less backfat, 6 cm<sup>2</sup> greater loin eye area, 6.1% greater lean, and 7.7 higher Minolta score than I and C ( $P < .01$ ), but differences in pH were not significant. Selection for litter size produced few correlated responses in growth and carcass traits.

**Key Words:** litter size, growth, carcass

**29 Breed differences of porcine longissimus dorsi soluble myoglobin concentration.** R. N. Goodwin<sup>\*1</sup>, B. R. Weigand<sup>2</sup>, and F. C. Parrish<sup>3</sup>, <sup>1</sup>National Pork Producer's Council, <sup>2</sup>Illinois State University, <sup>3</sup>Iowa State University.

Samples of longissimus dorsi (LOIN) were obtained from 255 purebred barrows (124) and gilts (131) centrally tested in the 1999 National Barrow Show Sire Progeny Tests. All pigs were HAL-1843 nonmutant genotype. Number of sires and pigs per breed are Berkshire(14,67), Chester White(6,28), Duroc(13,61), Hampshire(4,17), Landrace(4,12), Poland China(6,28) and Yorkshire(7,41). A bone-in section of LOIN was taken from the tenth to twelfth rib twenty four hours post slaughter. Ultimate pH (PH) and Hunter L-value (L-24) were measured at the tenth rib LOIN surface twenty four hours post slaughter. Chilled samples were transported to the Iowa State University Meat Laboratory. At forty eight hours post slaughter measurements of Hunter L-value (L-48), NPPC Color score (COL), Japan Color score (JAPAN), water holding capacity (WHC), Hunter L\*-value (L\*), Hunter a\*-value (a\*), and Hunter b\*-value (b\*) were taken at the eleventh rib LOIN surface. A LOIN sample was evaluated for total lipid percent (IMF). A LOIN sample was evaluated for soluble myoglobin concentration (MYO, mg/g) by the method of Hunt. A mixed linear model including the fixed effects of slaughter day, breed, and sex of pig and the random effects of sire(breed) and dam(breed) was used. A REML algorithm was used to estimate variance components. Heritability of MYO calculated from sire variance is .27. Breed means of MYO, L\*, a\*, PH, L-24, L-48, WHC, JAPAN, and COL were different ( $P < .05$ ). Chester White (.92), Duroc (.85) and Hampshire (.95) LOIN had the highest MYO. Landrace (.62)

and Yorkshire (.73) had the lowest MYO. A multivariate fixed model including breed and slaughter day effects produced residual correlations among measures. Residual correlations with MYO were L\* (-.17), a\* (.23), b\* (-.15), JAPAN (.13), COL (0), PH (0), L-24 (-.16), L-48 (-.13), IMF (.18), and WHC (0).

**Key Words:** Swine, Pork quality, Myoglobin

**30 Evaluation of Duroc vs. Pietrain sired progeny: I. growth parameters.** D. B. Edwards<sup>\*</sup>, R. O. Bates, P. M. Saama, and R. J. Tempelman, Michigan State University, E. Lansing, MI/USA.

Novel swine populations may contribute beneficial genes to U.S. swine production systems. Crossbred progeny sired by either Duroc or ryanodine receptor gene normal Pietrain were used in this study. Boars from each breed were mated to Yorkshire or F<sub>1</sub> Yorkshire-Landrace females. A total of 307 offspring were evaluated for growth traits. No significant differences were seen for pig weight from birth through 10 wk of age. Weight and B-mode ultrasound estimates of 10<sup>th</sup> rib backfat (BF10), loin muscle area (LMA), and last rib back fat (LRF) were serially measured from 10 to 26 wk of age. Data were analyzed using an animal model with fixed effects of trial replication, breed of sire, breed of dam, gender, the interaction of breed of sire and gender, random effect of animal, and age of the animal as a covariate. At 26 wk of age Duroc sired progeny were heavier (143.2 vs. 133.0 kg,  $p < .0001$ ), had more BF10 (27.25 vs. 23.67 mm,  $p < .0001$ ) and LRF (21.59 vs. 19.23 mm,  $p < .001$ ), but had similar LMA (45.93 vs. 46.97 sq cm) to the Pietrain sired progeny. Feed efficiencies were not different between each breed of sire in any of the time periods of the study. Duroc progeny had a higher ADG (978.7 vs. 893.9 g/d,  $p < .0001$ ) from 10 to 26 wk of age. Animal models with polynomial regressions on age were fitted to describe body weight, BF10, LMA, and LRF from 10 to 26 wk of age. Different equations were estimated for the each breed of sire. All traits were modeled against days of age. Quartic polynomial models best fit body weight, LMA, and LRF, however, a cubic polynomial model best fit BF10. Both sire breeds have beneficial traits that can be utilized in commercial pork production and merit further study.

**Key Words:** pig, growth curves, regression analysis

**31 Prediction of Percent Intramuscular Fat in Live Swine.** D. Newcom<sup>\*</sup>, A. Hassen, T.J. Baas, D.E. Wilson, G.H. Rouse, and C.L. Hays, Iowa State University, Ames, IA.

The objective of this study was to develop models to predict percent intramuscular fat (PIMF) in live swine using longitudinal real-time ultrasound scans. Yorkshire and Duroc barrows and gilts (n=500) from test group 1 of the National Pork Producers Council's Genetics of Lean Efficiency Project (GLEP) were scanned five days prior to slaughter. A minimum of four longitudinal images were collected from each pig across the 10<sup>th</sup> to 13<sup>th</sup> ribs, 5cm off midline, using an Aloka 500V ultrasound machine equipped with a 12.5cm, 3.5 MHz linear array transducer. Two trained technicians used texture analysis software to define Fourier, gradient, histogram, and co-occurrence parameters. These parameters (n=10) were used as independent variables in PIMF model development. After slaughter, a slice from the 10th rib face of the longissimus dorsi muscle was analyzed via ether extraction to determine percent intramuscular fat (IMF). Six models were developed; two for the entire data set and two for each breed. For each data set, Model 1 was a linear regression with no transformation of IMF and Model 2 was a linear regression with a log transformation of IMF. Model R<sup>2</sup> and root mean square error (RMSE) based on the overall data set were .53 and .69% for Model 1 and .52 and .70% for Model 2 respectively. R<sup>2</sup> and RMSE were .57 and .66% for Duroc Model 1 and .53 and .67% for Duroc Model 2. The corresponding R<sup>2</sup> and RMSE were .41 and .56% for Yorkshire Model 1 and .40 and .56% for Yorkshire Model 2 respectively. All models were validated using pigs (n=250) from test group 2 of the GLEP. The mean bias, standard error of prediction, and correlation coefficient for overall Model 1 were -.16%, .88%, and .61 respectively. The corresponding values for overall Model 2 were -.24%, .86%, and .62. Real-time ultrasound technology could be used to predict percent intramuscular fat in live swine.

**Key Words:** ultrasound, swine, intramuscular fat



**32 A response surface estimated from the regression of standard cut and boneless pork primal yield on carcass backfat, loin depth and carcass weight measured on-line.** H. I. Sellers\*<sup>1</sup>, R. N. Goodwin<sup>1</sup>, and E. P. Berg<sup>2</sup>, <sup>1</sup>National Pork Producers Council, Des Moines, IA, <sup>2</sup>University of Missouri, Columbia.

Data from the National Pork Producers Council's Quality Lean Growth Modeling Project were used to estimate a response surface from the regression of IMPS standard cut and boneless primal yield on Fat-o-Meter (SFK Technologies) and AUS (Animal Ultrasound Services, Inc.) on-line readings and carcass weight. The pigs represented barrows and gilts from six genetic types fed four diet regimens and slaughtered at three target live weights. The genetic types were selected to represent high, medium and low attributes for growth, appetite and meat quality. At slaughter one-half of each carcass was cut according to IMPS standards to yield the primals Ham401, Loin410, Picnic405, Boston Butt406, Belly409 and Sparerib416. These were summed to create the variable IMPS Primal Yield (PY). The primal cuts were further processed into boneless primal cuts including the ham inside, outside and knuckle muscles, whole loin, tenderloin, picnic and Boston Butt. These primal cuts plus Belly409 were summed to create the variable Boneless Primal Yield (BPY). The model fit to produce the response surface was a complete quadratic of backfat depth, loin depth and carcass weight. The error mean squares for IMPS PY was 3.315 ( $R^2=0.961$ ) and 6.473 ( $R^2=0.929$ ) for the FOM and AUS models, respectively. Only the linear coefficients for carcass weight were significant ( $P<0.001$ ) in each model. The error mean squares for BPY were 3.495 ( $R^2=0.926$ ) and 6.473 ( $R^2=0.863$ ) for the FOM and AUS models, respectively. In the FOM model the linear coefficient for carcass weight and quadratic coefficients for carcass weight, backfat depth and loin depth were each significant ( $P<0.10$ ). In the AUS model the linear coefficient for carcass weight and the quadratic coefficients for backfat and loin depth were each significant ( $P<0.10$ ).

**Key Words:** Pork Carcass, Primal Yield, Response Surface

**33 Breed and fresh quality trait effects on dry-cured processed hams.** K. J. Stalder\*<sup>1</sup>, C. C. Melton<sup>1</sup>, G. E. Conatser<sup>1</sup>, S. L. Melton<sup>1</sup>, J. R. Mount<sup>1</sup>, M. P. Penfield<sup>1</sup>, D. Murphey<sup>2</sup>, and K. J. Goddard<sup>3</sup>, <sup>1</sup>University of Tennessee, Knoxville, <sup>2</sup>Tennessee Valley Meats, Paris, TN, <sup>3</sup>University of Tennessee, Paris.

Country ham processors incur economic losses as a result of poor processing yield of dry-cured products. The objectives of this study were 1. to determine if Duroc hams have more desirable processing qualities than hams of unknown genetic origin and 2. to determine whether fresh-ham quality indicators could be useful in predicting dry-cured processing characteristics. Hams (Duroc  $n=64$ , genetically undefined  $n=70$ ) were processed on two dates. Traits measured on fresh hams included weight, moisture, circumference, depth, temperature, color, marbling, firmness and pH. Cured weight and weight loss were evaluated when the hams were removed from the drying rooms and at slicing. Objective ham color evaluations were made using a Minolta CR-310 Chroma Meter with a 50 mm orifice on the butt face of fresh and center cut slices of cured hams. Cured-ham yield was calculated from the weights taken when initially processed, when the hams were removed from drying rooms and when sliced. Color was objectively measured on center cut ham slices at the time of cutting. Yield differences among the Duroc and genetically undefined were not different ( $P > 0.05$ ) when evaluated from the drying or slicing phases. Lack of breed yield differences may have resulted from varied amounts of skinning that occurred on the Duroc hams when the pigs were harvested. Coefficients of correlation between yield and fresh ham objective color scores were approximately -0.30 ( $P < 0.01$ ). Correlations between dry yield (sliced yield) and pH, intramuscular fat, and subjective scoring of color, marbling, and firmness were 0.15 (0.30), 0.07 (0.21), 0.29 (0.29), 0.31 (0.35) and 0.31 (0.40), respectively. Correlations between the objective (subjective) color scores made on the fresh hams and the objective color scores made on center cut slices of cured hams were low and not significant from zero ( $P > 0.05$ ). More research is needed to evaluate breed and other effects on dry-cure processing of hams.

**Key Words:** dry-cured ham, yield, Duroc

**34 Analysis of sow productivity in Costa Rica.** M.D. Hoge\*<sup>1</sup>, R.O. Bates<sup>1</sup>, and J. Camacho-Sandoval<sup>2</sup>, <sup>1</sup>Michigan State University, East Lansing, MI/USA, <sup>2</sup>Universidad Nacional, Heredia/Costa Rica.

Farrowing records ( $N=27,496$ ) from 9 commercial operations in Costa Rica were used to study the effects of farm, breed composition of the sire of the litter (SireBr), breed composition of the sow (SowBr), parity and number of services per conception (NoServe) on various litter traits. Initially there were 25 SireBr and 62 SowBr. These were reduced, depending on their breed composition, to 5 levels (maternal purebred (MP), terminal purebred (TP), maternal two-way cross (MTWO), dual purpose two-way cross (DTWO) and three-way cross (THREE)). Response variables were number born alive (NBA), number born dead (NBD), total number born (TNB), average pig birth weight (AvgBW), number weaned (NoWean) and pig weaning weight (WeanWt). Mixed models were used with SireBr, SowBr, NoServe, parity and the interaction of SowBr x parity as fixed effects with Farm as a random effect. Covariates used were WeanWt and age at weaning for the analysis of NoWean and age at weaning and NoWean for the analysis of WeanWt. Linear contrasts were used to partition the response within parity and SowBr. All fixed effects in the models were significant ( $P<0.01$ ) with the exception of SowBr for NoWean and NoServe for NBA. Results reveal that MP and TP were significantly lower ( $P<0.01$ ) compared to the other SowBr for NBA (-2.17), TNB (-1.32), AvgBW (-0.15kg) and WeanWt (-0.77kg), but were higher for NBD (0.85). No differences were noted for NoWean. The MTWO and DTWO were lower ( $P<0.01$ ) compared to THREE for NBA (-0.52), TNB (-0.48), but were higher ( $P<0.05$ ) for WeanWt (0.31kg). Contrasts for parity (1-2, 3-6, 7-10) revealed that parity 1 and 2 were lower ( $P<0.01$ ) than 3 through 6 for NBA (-1.89), NBD (-0.41), TNB (-2.31) and WeanWt (-0.28kg), but were similar for AvgBW and NoWean. Sows higher than parity 6 had more NBD, fewer NBA, lower AvgBW(kg) and weaned fewer pigs than parity 3 through 6 (1.49, -1.80, -0.21, -1.00, respectively ( $P<0.01$ )). Results suggested there were differences between parities and SowBr for litter traits.

**Key Words:** Sow, Breed, Litter traits

**35 Genetic evaluation of Holstein sires for incidence of twins.** J. M. Johanson\*<sup>1</sup>, P. J. Berger<sup>1</sup>, B. W. Kirkpatrick<sup>2</sup>, and M. R. Dentine<sup>2</sup>, <sup>1</sup>Iowa State University, <sup>2</sup>University of Wisconsin, Madison.

Calving data of North American Holsteins were analyzed using a linear sire model and a threshold sire model to estimate fixed effects and to predict sire transmitting abilities for incidence of twins. The data were 1,324,678 births of 37,174 sires of dams from the National Association of Animal Breeders (NAAB) calving ease database. The incidence of twins was 5.02%. No differentiation between monozygotic and dizygotic twins was available, so all twins were assumed to be dizygotic. The sire model included fixed effects of herd-year, season, and parity. The relationship among sires was also included to estimate the random effects of the sires of dams. Heritabilities for the sire of the dam effect were estimated to be 2.10% by the linear model analysis and 8.71% by the threshold model analysis. There is ample opportunity to identify sires of cows with either low or high incidence of twins. The sire evaluations ranged from 1.6% to 8.0%. Use of sires with a low PTA for twinning can reduce the incidence of twins. The parity effect showed a trend from the first to the fifth parity of 1.17%, 3.95%, 5.11%, 5.54%, and 5.54%, respectively. Incidence of twins for winter, spring, summer, and fall seasons were 4.17%, 4.48%, 3.65%, and 3.17%, respectively.

**Key Words:** threshold model, twins, heritability

**36 Genetic parameter estimates for breeding soundness traits in yearling Angus bulls.** R. A. Christmas, D. W. Moser\*, M. F. Spire, J. M. Sargeant, and S. K. Tucker, Kansas State University, Manhattan, KS.

Breeding soundness examination data from 1,282 registered Angus bulls in four herds were used to estimate genetic parameters of breeding soundness traits, presence of seminal white blood cells, and common penile defects. Average age of the bulls at the time of evaluation was 383 days. Data were analyzed using single- and two-trait animal models and a derivative-free REML algorithm. Estimates of heritability for scrotal circumference (SC), percent motility, percent primary abnormalities, percent secondary abnormalities and percent total abnormalities

were .56, .07, .35, .26 and .29, respectively. Estimates of heritability for the presence of seminal white blood cells, persistent penile frenulum, and penile fibropapillomatosis (warts) on the underlying normal scale were .02, .00, and .004, respectively. Genetic correlations between SC and semen quality parameters were low to moderate and favorable. Phenotypic correlations between SC and semen quality estimates were low and favorable. These results indicate that SC is the most heritable of breeding soundness components and that no undesirable responses in semen quality traits can be expected as a result of selection for increased SC. Conditions such as seminal vesiculitis, persistent penile frenulum, and penile fibropapillomatosis are of low heritability, and if corrected through management or treatment, should not be selected against by producers.

**Key Words:** genetic parameters, scrotum, semen characters

### 37 Relationship of genetic variants in the ovine calpain regulatory gene with growth. H. Chung, M. Davis\*, and H. Hines, *The Ohio State University*.

Relationships of genetic variants of the ovine calpain gene on growth were examined in 50 purebred Polypay, 50 purebred Targhee, and 100 mixed breed sheep from the Ohio Agricultural Research and Development Center (OARDC). Genotyping was performed by PCR-SSCP (single strand conformation polymorphism) analysis of the calpain regulatory segments. Following the selection of PCR primers based on the bovine cDNA sequences, primers were generated from calpain IV, exons 4 and 5 (CAPN445), exons 5 and 6 (CAPN456), and exons 7 and 8 (CAPN478). Genetic polymorphisms were detected in all of the calpain IV segments. Birth weight and weaning weight were recorded on lambs born in 1998. The statistical model for this analysis included fixed effects of calpain genotypes and age of dam, and a covariate for age of lamb. Genetic polymorphisms among individuals were observed for all segments (AA, AB, and BB). No significant influence of genotypes was found on birth weight (BW) or weaning weight (WW). However, CAPN445 explained variation in BW ( $P=.11$ ), and WW ( $P=.06$ ). It may not be beneficial to use calpain IV genotypes classified by PCR-SSCP in marker assisted selection programs to improve growth traits of lambs.

**Key Words:** Calpain IV, Growth, PCR-SSCP

### 38 Effects of calpastatin genotypes on growth and IGF-I concentration of Angus bulls. M. Davis\*, H. Chung, and H. Hines, *The Ohio State University*.

Effects of calpastatin genotypes on growth and IGF-I concentration were examined in 47 purebred Angus bulls divergently selected for blood serum IGF-I concentration at the Eastern Ohio Resource Development Center (EORDC). Genotyping was performed by PCR-SSCP (single strand conformation polymorphism) and RFLP (restriction fragment length polymorphism) analysis of the calpastatin segments. The PCR primers were selected from the bovine calpastatin cDNA for the unique domain L (CAST1, CAST5, and CAST6), domain 1 (CAST10), and domain IV (CAST28). The IGF-I concentration on d 28 (IGF28), 42 (IGF42), and 56 (IGF56) of the 140-d postweaning test was measured. Birth weight (BW), weaning weight (WW), on-test weight (ONW), weight on d 28 (W28), 42 (W42), and 56 (W56) of the postweaning test, and off-test weight (OFW) also were measured. Fixed effects in this analysis were genotypes, IGF-I selection line (high vs. low), age of dam, and a covariate for age of bull. Genetic polymorphisms among individuals were observed for all calpastatin segments. The CAST1 genotypes influenced WW ( $P=.06$ ), W28 ( $P=.06$ ), W42 ( $P=.04$ ), W56 ( $P=.04$ ), and W140 ( $P=.01$ ), but no influence was detected on BW or IGF-I traits. The CAST6 ( $P=.06$ ), CAST10 ( $P=.01$ ), and CAST28 ( $P=.04$ ) genotypes explained variation in BW. The CAST5 and CAST10 genotypes accounted for significant variation in the IGF-I traits. Genetic variants discovered in this study may provide useful information for future selection programs.

**Key Words:** Calpastatin, IGF-I, PCR-SSCP

### 39 Comparison of selective DNA pooling with selective genotyping for QTL mapping. H. H. Zhao\*, J. Wang, and J.C.M. Dekkers, *Iowa State University, Ames*.

Selective DNA pooling is an efficient method to map QTL based on differences in marker allele frequencies in DNA pools from phenotypic extremes. Although selective DNA pooling has much lower genotyping costs, it is expected to result in lower power and precision of QTL mapping than selective genotyping, for which animals in the extremes are genotyped individually. The objective of this study was to quantify this loss in power and precision for an example design. A backcross family of 2000 progeny with 6 evenly distributed markers along a chromosome that contained a QTL with a substitution effect of 0.25 phenotypic standard deviations ( $\sigma_P$ ) was simulated. The top and bottom 10% were selected for individual genotyping and DNA pooling. Observed DNA pool frequencies were simulated by adding a random technical error ( $N(0, \sigma_{te}^2)$  with  $\sigma_{te}$  equal to 0 or 0.053) to simulated marker allele frequencies in the tails. Selective genotyping data were analyzed by maximum likelihood interval mapping and selective DNA pooling data by least squares regression interval mapping. Results are based on 100 replicates. Five percent chromosome-wise significance thresholds were determined empirically. Both methods gave unbiased estimates of QTL location and effect (see Table). Selective DNA pooling resulted in greater variance of estimates of QTL parameters and lower power than selective genotyping. Precision and power of selective DNA pooling increased substantially in the absence of technical errors. In conclusion, selective DNA pooling is an efficient strategy for mapping QTL in large families, with only moderate losses in precision and power, in particular if technical error is low.

**Table 1. Comparisons of bias, precision, power and number of genotypings from selective DNA pooling (with or without technical error) with selective genotyping**

	QTL location		QTL effect		Power	Number of genotypings
	Bias (cM)	Std. Err. (cM)	Bias ( $\sigma_P$ )	Std. Err. ( $\sigma_P$ )		
Selective						
Genotyping	-0.77	8.2	0.011	0.058	0.99	2400
DNA pooling ( $\sigma_{te}=0.0$ )	0.59	11.5	-0.001	0.064	0.74	12
DNA pooling ( $\sigma_{te}=0.053$ )	1.16	19.0	0.009	0.076	0.62	12

**Key Words:** Selective DNA Pooling, Selective Genotyping, QTL Mapping

### 40 Evaluation of Duroc vs. Pietrain sired progeny: II. carcass measurements. D. B. Edwards\*, R. O. Bates, and W. N. Osburn, *Michigan State University, E. Lansing, MI/USA*.

Novel swine populations may contribute beneficial genes to U.S. swine production systems. Crossbred progeny sired by either Duroc or ryanodine receptor gene normal Pietrain were used in this study. Boars from each breed were mated to Yorkshire or F<sub>1</sub> Yorkshire-Landrace females. A total of 162 offspring were evaluated for carcass traits. Measurements were taken on animals representative of each litter. Data were analyzed using an animal model with fixed effects of breed of sire, breed of dam, gender, slaughter group, the interaction of breed of sire and gender, random effect of animal, and age of the animal as a covariate. At similar ages, Duroc sired progeny had higher carcass weights (107.95 vs. 102.98 kg,  $p<.0001$ ), and were longer (86.91 vs. 84.78 cm,  $p<.01$ ), while Pietrain sired pigs had less back fat at the first rib (44.55 vs. 47.65 mm,  $p<.01$ ), at the last lumbar vertebrae (20.85 vs. 22.96 mm,  $p<.05$ ), and at the tenth rib (23.04 vs. 25.48 mm,  $p<.01$ ). No difference between Pietrain and Duroc progeny was seen for fat depth at the last rib (27.79 vs. 28.75 mm, respectively). Pietrain progeny had a higher percent lean at slaughter (52.60 vs. 50.74,  $p<.05$ ) and higher dressing percentage (73.96 vs. 73.08,  $p<.01$ ). Primal cut weights were collected with Pietrain progeny having a larger percentage of the carcass as ham (23.02 vs. 22.44,  $p<.01$ ) and loin (21.59 vs. 21.21,  $p<.05$ ), while Duroc progeny had a larger percentage for bellies (11.99 vs. 11.66,  $p<.05$ ). Duroc versus Pietrain percentages on boston (8.80 vs. 8.96) and picnic (9.85 vs. 9.91) shoulders were similar. With higher carcass weights, Duroc progeny had higher primal cut weights as a function of age. Both sire breeds have beneficial traits that can be utilized in commercial pork production and merit further study.

**Key Words:** pig, carcass measures, breeds

**41 A polymorphism identified in the 5' flanking region of the ovine IGF-I gene by PCR-SSCP analysis.** A. Yilmaz\*, M. E. Davis, and H. C. Hines, *The Ohio State University, Columbus, OH.*

The objective of this study was to search in the ovine insulin-like growth factor I (IGF-I) gene for mutations that may be related to production traits such as liveweight and number of multiple births, using Polymerase Chain Reaction (PCR) and Single-Strand Conformation Polymorphism (SSCP) analysis. The breeds utilized were crossbreds or purebreds of Polypay, Hampshire, Targhee, Rambouillet, Dorset, and Suffolk. A fragment of approximately 265 base pairs in the 5' flanking region of the ovine IGF-I gene, about 530 to 795 bp upstream from the 3' end of exon 1, was amplified for SSCP analysis. Sequences of primers that were used in PCR were 5'-ATTACAAAGCTGCCTGCCCC-3' (forward primer) and 5'-CACATCTGCTAATACACCTTACCCG-3' (reverse primer). A PCR-SSCP polymorphism was detected in the 5' flanking region of the ovine IGF-I gene. Twenty mixed-breed sheep were examined, and three distinct genotypes were observed (AA, 0.70; BB, 0.05; and AB, 0.25). Calculated allele frequencies were A = 0.82 and B = 0.18. In addition, genotypic frequencies were determined in 22 purebred Polypay sheep (AA, 0.77 and AB, 0.23). Calculated allele frequencies in Polypays were: A = 0.89; B = 0.11. Observed and expected numbers of the respective genotypes in mixed-breed and Polypay sheep indicated the existence of Hardy-Weinberg Equilibrium (chi-square test statistic = 0.47,  $P > 0.10$ ,  $df = 2$ ). Codominant segregation of alleles was observed in six paternal half-sib progeny, which confirmed Mendelian inheritance. The mutation in the 5' flanking region of the IGF-I gene that resulted in three distinct genotypes in sheep will be further investigated to determine if it influences production traits of sheep.

**Key Words:** Insulin-like Growth Factor I, Single-Strand Conformation Polymorphism, Sheep

**42 A comprehensive search for quantitative trait loci affecting growth and carcass composition of cattle segregating alternative forms of the myostatin gene.** E. Casas\*<sup>1</sup>, R. T. Stone<sup>1</sup>, J. W. Keele<sup>1</sup>, S. D. Shackelford<sup>1</sup>, S. M. Kappes<sup>2</sup>, and M. Koohmaraie<sup>1</sup>, <sup>1</sup>USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE, <sup>2</sup>USDA-ARS, National Program Staff, Beltsville, MD.

Effects of the bovine myostatin gene and additional quantitative trait loci (QTL) have been previously assessed. The objective of this study was to identify further QTL for economically important traits. Two half-sib families were developed from a Belgian Blue x MARC III (n = 246) and a Piedmontese x Angus (n = 209) sire. Traits analyzed were birth, weaning, and yearling weight (kg); preweaning average daily gain (kg/d); postweaning average daily gain (kg/d); hot carcass weight (kg); fat depth (cm); marbling score; longissimus muscle area (cm<sup>2</sup>); estimated kidney, pelvic, and heart fat (%); USDA yield grade; retail product yield (%); fat yield (%); and wholesale rib-fat yield (%). Meat tenderness was measured as Warner-Bratzler shear force (kg) at 3 and 14 d postmortem. A total of 89 markers were used. In the family of Belgian Blue inheritance, a significant QTL (expected number of false positives = 0.025; ENFP) was identified for marbling score on chromosome 3. Suggestive QTL for the same family (ENFP = 0.5) were identified for retail product yield on chromosome 3, for hot carcass weight and postweaning average daily gain on chromosome 4, for fat depth and marbling score on chromosome 8, for 14-d Warner-Bratzler shear force on chromosome 9, and for marbling score on chromosome 10. Evidence suggesting the presence of an interaction for 3-d Warner-Bratzler shear force between the myostatin gene and a QTL on chromosome 4 was detected. In the family of Piedmontese and Angus inheritance, evidence indicates the presence of an interaction for fat depth between the myostatin gene and chromosome 8. Regions identified underlying quantitative trait loci need to be assessed in other populations. Although the myostatin gene has a considerable effect, other loci with subtle effects are involved in the expression of the phenotype.

**Key Words:** Beef, Genetic Markers, Quantitative Trait Loci

**43 Associations of Leptin Gene Marker with Carcass Traits in Cattle.** C. D. Bierman\* and D. M. Marshall, *South Dakota State University, Brookings, SD.*

Objectives of this study were to determine the effects of leptin (ob) genotype on fat and muscle traits in crossbred cattle. A single nucleotide polymorphism located in exon 2 of the ob gene in cattle codes for an amino acid change from an arginine (R) to a cysteine (C). Genotypes for leptin were determined on crossbred calves (n = 492) by *AcI* digestion of amplified PCR product (C allele: 130bp; R allele: 73bp and 57bp). The genotypic frequencies of CC, CR, and RR were .240, .561, and .199, respectively within the calves. Data were analyzed by least-squares, accounting for effects of genotype, sex, year, location, and breed-type. Three analyses were performed, adjusting for covariates of carcass weight, fat thickness, or age at slaughter. Subjective marbling scores (assigned by USDA grader; 350 = slight 50, 400 = small 0, 450 = small 50) were higher (P = .02) for CC (411 units) than for RR (388 units) genotype when adjusted to a constant slaughter age (433 days). Similar differences between genotypes in marbling scores were observed when adjusting to a constant carcass weight (328 kg) or external fat thickness (11.5 mm). The effect of genotype on external fat thickness approached significance when analyzed on a weight-constant basis (12.9 and 12.1 mm for CC and RR, respectively; P = .07). The effect of genotype was nonsignificant for carcass weight and longissimus muscle area. In conclusion, leptin genotypic effects were significant, though modest in magnitude, for traits related to intra-muscular and subcutaneous fat accretion.

**Key Words:** Cattle, Leptin, Gene marker

**44 Heritability and correlation estimates of carcass data from Angus-sired steers.** J.A. Minick\*<sup>1</sup>, D.E. Wilson<sup>1</sup>, M.E. Dikeman<sup>2</sup>, and E.J. Pollak<sup>3</sup>, <sup>1</sup>Iowa State University, Ames, Iowa, <sup>2</sup>Kansas State University, Manhattan, Kansas, <sup>3</sup>Cornell University, Ithaca, New York.

The objective of this study was to estimate heritabilities and genetic correlations for Warner-Bratzler shear force in kg (WB), marbling score (MS), hot carcass weight in kg (HCW), 12-13th rib fat in mm (FAT) and ribeye area in cm squared (REA). There were 589 steers sired by 28 Angus bulls in the National Cattleman's Beef Association Carcass Merit Project. Number of progeny per sire ranged from 5 to 47. Because age did not significantly affect any of the carcass traits, none of the records were adjusted. REML estimates of the genetic parameters were determined using the sire/maternal-grandsire model with the relationship matrix. This model accounts for contemporary groups, which were derived from farm of origin and slaughter date. Multiple-trait analyses, including all two-trait, three-trait and four-trait combinations and a five-trait analysis were run. The table shows the averages for all the analyses with heritabilities  $\pm$  standard errors on the diagonal, genetic correlations above the diagonal, and phenotypic correlations below the diagonal. For WB, MS, HCW, FAT and REA, heritabilities ranged from .22-.27, .28-.30, .77-.80, .04-.10 and .56-62, respectively. The means  $\pm$  standard deviations were WB: 3.72  $\pm$  0.79, MS: 5.57  $\pm$  0.87, HCW: 358.32  $\pm$  31.08, FAT: 14.05  $\pm$  3.65 and REA: 81.74  $\pm$  7.66.

	WB	MS	HCW	FAT	REA
WB	.25 $\pm$ .18	-.04	.64	.21	.42
MS	-.18	.29 $\pm$ .19	-.15	-.51	.23
HCW	.12	.19	.79 $\pm$ .29	.07	.64
FAT	-.03	.19	.26	.07 $\pm$ .11	-.77
REA	.19	0	.38	-.19	.59 $\pm$ .25

**Key Words:** Beef cattle, Carcass, Genetic parameters

**45 Heterogeneity of variance and estimation of genetic parameters.** L. D. Van Vleck\*<sup>1,3</sup>, R. K. Splan<sup>2</sup>, and L. V. Cundiff<sup>1,4</sup>, <sup>1</sup>USDA-ARS USMARC, <sup>2</sup>Virginia Tech, Blacksburg, VA, <sup>3</sup>Lincoln, NE, <sup>4</sup>Clay Center, NE.

The Germ Plasm Evaluation (GPE) project at the USMARC encompasses two generations of matings. The F1 progeny of several sire breeds mated to Hereford and Angus cows are measured directly. The F1 heifers are then mated to bulls of other breeds which allows for expression of maternal characteristics of the original sire breeds. The two sets of data can be combined to estimate direct (h-2) and maternal (m-2) heritability and the direct-maternal genetic correlation r(a,m). For this study, 14

sire breeds were included. Two traits, birth weight (BWT) and weaning weight (WWT) were analyzed. The numbers of observations available were 3,530 and 5,610 for direct BWT and WWT and 7,095 and 8,591 for maternal BWT and WWT. For WWT, little discrepancy was found between separate analyses of the two data sets and the combined data set or when standardized by dividing by the respective standard deviations. For BWT, h-2 estimates were .48 and .35 for direct and maternal data but for the combined data, h-2 was .64, m-2 was .06, and r(a,m) was -.23. When records within data set were standardized by dividing by the respective standard deviations; h-2, m-2, and r(a,m) were .54, .06, and -.03. When records were standardized by the unadjusted standard deviations; h-2, m-2, and r(a,m) were .45, .06, and .18. For WWT, ratio of phenotypic SD for the two data files was (23.5/21.8). For BWT, the ratios were 4.35/4.57 and 5.36/6.09 (unadjusted). Heterogeneity of variance across generations and method of standardizing variances seem to influence estimates of heritability and the direct-maternal genetic correlation.

**Key Words:** Genetic Parameters, Beef Cattle, Growth

**46 Genetic parameters for scrotal circumference and age at puberty in beef cattle.** G. Martinez-Velazquez<sup>\*1</sup>, K. E. Gregory<sup>2</sup>, G. L. Bennett<sup>2</sup>, and L. D. Van Vleck<sup>2,3</sup>, <sup>1</sup>University of Nebraska, Lincoln, NE, <sup>2</sup>USDA, ARS, USMARC, <sup>2</sup>Clay Center, NE, <sup>3</sup>Lincoln, NE.

Data from 12 *Bos taurus* breeds for scrotal circumference (n = 7, 277) and age at puberty (n = 7, 580) collected at MARC-USDA between 1978 and 1991 were used to estimate heritabilities and genetic correlations. Age at puberty (AP) was defined as the age (days) at first detected ovulatory estrus. Scrotal circumference (SC) was measured (cm) in males at about 358 days of age. The final model for SC included fixed effects of breed (B), age of dam (A), year of birth (Y) and all interactions. Age at measurement of SC was included as a covariate (linear and quadratic) in the model. For AP the final model included the fixed effects of B, A, Y, month of birth and all interactions. For both traits random effects in the model were direct genetic, maternal genetic, maternal permanent environmental, and residual. A bivariate analysis for a two trait animal model was used to estimate the (co)variance components using a derivative free REML algorithm. Heritability estimates were .41 (direct) and .07 (maternal) for SC, and .36 (direct) and .04 (maternal) for AP. Genetic correlations between direct and maternal genetic effects (within trait) were -.12 and -.90 for SC and AP, respectively. Genetic correlations between SC and AP were -.16 (direct), -.30 (maternal), -.12 (direct SC with maternal AP), and .13 (direct AP with maternal SC). The phenotypic variances were 5.90 (SC) and 442.90 (AP). The phenotypic covariance was 3.66. Estimates of direct heritability for SC and AP agree with estimates published by other authors. The estimates of genetic correlations between SC and AP suggest a favorable genetic association. The negative genetic correlations between direct and maternal effects (within trait) and the estimates of direct and maternal heritability suggest that a selection program for SC and AP should consider maternal genetic effects.

**Key Words:** Heritability, Reproduction, Maternal Effects

**47 Genetic parameters for reproductive traits in beef cattle.** G. Martinez-Velazquez<sup>\*1</sup>, K. E. Gregory<sup>2</sup>, G. L. Bennett<sup>2</sup>, and L. D. Van Vleck<sup>2,3</sup>, <sup>1</sup>University of Nebraska, Lincoln, NE, <sup>2</sup>USDA, ARS, USMARC, <sup>2</sup>Clay Center, NE, <sup>3</sup>Lincoln, NE.

Data from 12 *Bos taurus* breeds for pregnancy rate (P1), calving rate (C1) and weaning rate (W1) for age at first breeding (n = 7,003), and pregnancy rate (P2), calving rate (C2) and weaning rate (W2) combining second to tenth age at breeding (n = 15,739) collected at MARC-USDA between 1979 and 1990 were used to estimate heritabilities and genetic correlations. Pregnancy (calving or weaning) rate was one if the female conceived (calved or weaned) a calf given exposure during the preceding breeding season and zero, otherwise. The final model for P1, C1 and W1 included fixed effects of breed (B), year of breeding (Y) and their interaction. For P2, C2 and W2 the final model included the fixed effects of B, Y, age at breeding (yr) and all interactions. For all traits, random effects in the model were direct genetic, maternal genetic, maternal permanent environmental, and residual. Univariate analyses with a single trait animal model were used to estimate the (co)variance components using a derivative-free REML algorithm. Unadjusted means were .75 ± .43, .71 ± .44, .59 ± .49, .84 ± .35, .81 ± .38 and .76 ± .42 for P1, C1,

W1, P2, C2 and W2, respectively. Heritability estimates were .15 ± .03 (direct) and .02 ± .01 (maternal) for P1, .15 ± .03 (direct) and .03 ± .01 (maternal) for C1 and .11 ± .02 (direct) and .00 ± .01 (maternal) for W1. Direct and maternal heritability estimates for P2, C2 and W2 ranged from .00 to .02. Genetic correlations between direct and maternal genetic effects (within trait) were -.83 ± .71 and -.68 ± .55 for P1 and C1, respectively. The phenotypic variances were .17 (P1), .18 (C1), .22 (W1), .12 (P2), .14 (C2), and .17 (W2). Heritability estimates indicate that management is an important factor affecting these traits especially after the first breeding season. Estimates of genetic correlations and estimates of direct and maternal heritability suggest unfavorable genetic associations between direct and maternal genetic effects for P1 and C1.

**Key Words:** Heritability, Reproduction, Maternal Effects

**48 Comparison of models for estimating direct and maternal genetic effects for weaning weight of Hereford cattle.** P. Sopannarath<sup>\*1</sup>, J. K. Bertrand<sup>2</sup>, L. D. Van Vleck<sup>3</sup>, and S. Tumwasorn<sup>4</sup>, <sup>1</sup>University of Nebraska, Lincoln, <sup>2</sup>University of Georgia, Athens, <sup>3</sup>USDA, ARS, USMARC, Lincoln, NE, <sup>4</sup>Kasetsart University, Bangkok, Thailand.

Weaning weights adjusted for age of calf and age of dam from 4 sets of Hereford cattle from the American Hereford Association were analyzed. Numbers of records ranged from 29,562 to 30,383. Variance and covariance components were estimated using REML. Ten animal models were applied to estimate genetic and environmental parameters. Model 1 included fixed contemporary group (weaning herd, work group, sex, management group, feeding code) and year-season effects and random direct and maternal genetic, maternal permanent and residual environmental effects. Based on Model 1, Models 2-9 additionally included sire x herd, sire x year, sire x sex, sire x age of dam, sire x herd-year, sire x herd-year-sex, sire x herd-year-sexage of dam and sire x dam interaction effects, respectively. Model 6 was significantly best (likelihood ratio test). Model 10 added sire x dam effects to Model 6 and improved the likelihood. Compared with Model 1, the log likelihood improved significantly for all sets. Model 1 gave highest estimates of direct and maternal h2 and negative direct-maternal correlations. With sire x dam interaction effects (Model 9), estimates were similar to Model 1. Estimates with Models 2-8 for direct and maternal h2 were smaller and r(a,m) was larger than Model 1 with similar fractions of variance due to maternal permanent environmental effects. Estimates from Models 6 and 10 were similar. With Model 10, estimates were 0.18 to 0.19 for direct h2, 0.14 to 0.16 for maternal h2, -0.40 to -0.31 for r(a,m), fractions of variance due to sire x herd-year and sire x dam interactions were 0.03 to 0.07 and 0.04 to 0.09, respectively. Results suggest that sire x herd-year interactions are important, with direct and maternal h2 biased upward and r(a,m) biased downward if sire x herd-year interaction effects are not included in model. Sire x dam interaction effects did not affect estimates of variances of other effects.

**Key Words:** Beef Cattle, Growth, Genetic Parameters

**49 Birth and weaning traits of topcross progeny of Hereford, Angus, Red Angus, Simmental, Gelbvieh, Limousin, and Charolais sires.** L. V. Cundiff<sup>\*</sup>, Roman L. Hruska U.S. Meat Animal Research Center, Clay Center, NE.

Data were obtained on 1,394 calves born in the spring of 1999 and 2000 and 1,351 calves weaned resulting from artificial insemination matings of Hereford (H, 21 sires), Angus (A, 22), Red Angus (Ra, 21), Simmental (S, 20), Gelbvieh (G, 23), Limousin (L, 20), and Charolais (C, 22) bulls to Hereford, Angus, and composite MARC III (1/4 each Angus, Hereford, Red Poll, and Pinzgauer) cows. Data on gestation length (GL), unassisted calving percentage (CE), survival to weaning (SW), birth weight (BW), and 200-d weaning weight (WW) were analyzed by least squares procedures using a model that included random effects for sire in sire breed and fixed effects for sire breed, dam breed, sex of calf, age of dam (4.5..10 yr), birth year, sire breed x dam breed, and any other two factor interactions that were significant (P<.05) for each trait. Effects of sire breed were significant (P<.01) for GL, CE, BW, and WW, but not for SW. The means for H, A, Ra, S, G, L, and C sired progeny were 284.2, 281.6, 282.1, 285.2, 284.4, 286.2, and 283.0 d, respectively, for GL with a mean least significant difference (LSD<.05) of 1.5 d. Corresponding sire breed means were 94.9, 99.0, 98.5, 97.7, 97.8, 97.6, and 92.8% for CE (LSD<.05 = 3.5%); 41.3, 38.4, 38.7, 41.8, 40.2, 40.6, and 42.5 kg for BW (LSD<.05 = 1.5 kg); and 237.7, 241.9, 238.8,

251.0, 242.2, 235.2, and 245.0 kg for WW (LSD<.05 = 6.4 kg). Ra did not differ significantly from A for any trait. A and Ra had shorter GL and lighter BW than all other sire breeds. CE was significantly greater for A and Ra than for H and C sire progeny. Weaning weights were

significantly heavier for S, and C sired progeny than for H, Ra, and L sired progeny.

**Key Words:** Beef Cattle, Breeds, Germplasm

## EXTENSION

### 50 Effects of feeding rate and protein concentration in milk replacers on growth and body composition of Holstein calves. K.S. Bartlett\*, J.K. Drackley, and F.K. McKeith, *University of Illinois*.

Male Holstein calves purchased during the first week of life were used to determine the effects of feeding rates and crude protein (CP) concentrations in whey-protein-based milk replacers on growth and body composition. Following a 2-wk adaptation period, calves were randomly assigned to either an initial slaughter group or to experimental treatments. In this portion of the study, 48 calves were assigned to treatments in a 2 x 4 factorial arrangement consisting of two feeding rates (10% or 14% of body weight [BW], adjusted weekly) and four CP concentrations (14%, 18%, 22%, and 26% CP). Calves were fed isocaloric milk replacers reconstituted to 12.5% DM; no starter was fed. Calves were slaughtered after 5 wk on treatment. Visceral organs were removed, weighed, and digesta stripped out of the gastrointestinal tract. Calves were processed into three fractions (carcass; head, hide, feet, and tail; and viscera), that were ground and analyzed. Average daily gain (ADG) in BW and gains in body components over the 35-d experiment are presented in the table.

Feeding		ADG, kg	Protein, kg	Water, kg	Fat, kg	Ash, kg	Energy, Mcal
CP rate (%)	(% of BW)						
14	10	0.25	0.93	2.97	1.87	0.25	20.82
14	14	0.51	2.12	8.08	3.69	0.50	40.87
18	10	0.31	1.34	4.96	1.48	0.31	17.82
18	14	0.56	2.69	9.95	3.23	0.21	41.66
22	10	0.41	2.14	7.10	1.54	0.28	20.64
22	14	0.69	3.67	13.47	2.98	0.71	44.17
26	10	0.36	1.91	6.21	1.13	0.23	16.98
26	14	0.70	4.06	14.11	2.80	0.86	41.74

The ADG were greater (P<0.01) for calves fed at 14% BW and increased linearly (P<0.01) as CP increased. Increasing CP concentration linearly increased (P<0.05) gains of protein and water, but linearly decreased (P<0.02) gain of fat in the body; total energy deposition was unaffected. The greater feeding rate increased (P<0.01) gains of water, protein, fat, ash, and energy. Tendencies (P<0.10) for interactions of feeding rate and the linear effect of increasing CP indicated that rates of lean tissue (water plus protein) deposition were increased more by higher dietary CP in calves fed at 14% BW than in those fed at 10% BW.

**Key Words:** Calves, Feeding rate, Protein

### 51 Effects of energy sources in milk replacers on growth and body composition of Holstein calves. K. S. Bartlett\*, F. K. McKeith, and J. K. Drackley, *University of Illinois, Urbana, IL*.

We tested the hypothesis that lactose promotes greater gains of lean body tissue in preruminant calves than does dietary fat. Male Holstein calves purchased during the first week of life were fed whole milk at 10% of body weight (BW) for a 2-wk adaptation period. Calves then were randomly assigned to either an initial slaughter group or to experimental treatments. In this portion of the study, 18 calves were assigned to diets of 1) conventional milk replacer (CMR; 22% CP, 21% fat, 49% lactose); 2) high fat milk replacer (HFMR; 26% CP, 27% fat, 42% lactose); or 3) whole milk (25% CP, 27% fat, 40% lactose). Reconstituted CMR was fed at 14% of BW; reconstituted HFMR and milk were fed at 11.65% of BW so that initial (wk 1) intakes of metabolizable energy (ME; 3.63, 3.62, and 3.56 Mcal/d for CMR, HFMR, and milk, respectively) and CP (177, 160, and 181 g/d) were similar. Intakes were adjusted weekly as calves grew; no starter was fed. Calves were slaughtered after 5 wk on treatment and processed into three fractions (carcass; head, hide,

feet, and tail; and viscera) for analysis. The average daily gain (ADG) was greater (P<0.001) for calves fed CMR than for those fed HFMR or milk (0.690, 0.532, and 0.571 kg/d). Calves fed CMR had greater gains of water (P<0.001) and ash (P<0.05) than calves fed HFMR or milk. Calves fed CMR tended (P<0.08) to have greater gains of protein than calves fed HFMR or milk, and calves fed HFMR tended (P<0.06) to have greater gains of protein than calves fed milk (0.105, 0.098, and 0.078 kg/d, respectively). Gain in energy tended (P<0.06) to be greater for calves fed CMR. Plasma urea concentration was lower (P<0.01) for calves fed CMR than for those fed HFMR or milk, and was greater (P<0.01) for HFMR than for milk (7.4, 10.7, and 8.3 mg/dl, respectively). We interpret these data to indicate that at equal ME intake, lactose promotes greater lean tissue (water plus protein) accretion than does fat.

**Key Words:** Calves, Body composition, Milk replacers

### 52 Evaluation of an oral immunoglobulin supplement for milk fed dairy calves. J. D. Quigley, C. A. Jaynes-Kost, and T. M. Anspach, *APC Company, Inc., Ames, IA*.

Two experiments were conducted to evaluate the potential value of oral immunoglobulins as feed additives for milk-fed calves. In experiment 1, Holstein bull calves (n = 120) were purchased from area dairy farms and were fed calf milk replacer (CMR; 20% protein, 20% ether extract, non-medicated) for 42 d. Calves were fed Gammulin® (G; APC Company, Inc.) or a placebo additive (P) for 15 d and a commercial calf starter (CS) from d 29. Total intake of G and P was 675 grams. Overall management and health of calves was excellent (total mortality = 0.8%) and calves were not stressed during the 56-d trial. Calves fed G tended to have fewer scour days (-23%, P < 0.07), less use of electrolytes (-39%, P < 0.10) and antibiotics (-50%, P < 0.16). Calves fed G also tended (P < 0.10) to have improved feed efficiency (459 vs. 422 g BW gain/kg DM intake) over the 56-d trial and improved BW gain from d 29 to 56 (665 vs. 589 g/d). In experiment 2, Holstein bull calves (n = 120) were purchased from area sale barns at approximately 5 d of age and were fed 454 g/d of CMR for 56 d. Commercial CS and water were offered for ad libitum consumption from d 1. Calves were fed G as in Experiment 1, but no P was fed. During the 56-d study, calves fed G had improved fecal scores (-6.1%, P < 0.06), fewer scour days (-42%, P < 0.02), and reduced use of antibiotics (-44%, P < 0.02). Intake of CMR, CS and water, BW gain and feed efficiency were unaffected. Changes in fecal scores and reductions in use of veterinary treatments were greatest during the first 15 d of the study. Mortality during the experiment was 10 calves, 7 of which were not fed G. These data indicate that provision of oral immunoglobulins in milk-fed calves can reduce the severity of enteric infections during the first 3 to 4 wk of life.

**Key Words:** calves, immunoglobulin, immunity

### 53 Effects of spray-dried whole egg in calf milk replacers on intake, growth and health of dairy calves. J. D. Quigley\*, C. A. Jaynes-Kost, and M. L. Miller, *APC Company, Inc., Ames, IA*.

Numerous feed ingredients have been evaluated as alternatives to milk proteins in calf milk replacer (CMR) formulations. We evaluated the use of spray-dried whole egg (SDWE), which is a significant source of protein (>50%) and fat (>35%) as an ingredient in CMR. Holstein bull calves (n = 120; mean age = 5.5 d) were purchased from area dairies and were assigned to receive CMR containing 0, 10, or 20% of the CMR formulation as SDWE, which replaced whey protein concentrate and animal fat. All CMR were formulated to contain 22% crude protein and 22% ether extract. Amount of CMR was increased from 454 g/d at d 1 to 726 g/d at d 28; thereafter amount of CMR was reduced to weaning at 42 d. All CMR were formulated to provide 0 or 1 mg/kg of supplemental biotin and contained oxytetracycline and neomycin. Commercial calf starter was available from d 29 to 56 and water was available throughout

the study. Supplementation with biotin had no effect on any parameter measured. Increasing SDWE caused a linear decline in BW at 28 and 56 d, reduced BW gain, starter intake, total DM intake, water intake, and impaired feed efficiency. Mean BW gains from d 0 to 28 were 231, 70, and 0 g/d for calves fed 0, 10, and 20% SDWE, respectively. Body weights at 56 d were 73.1, 66.5 and 62.1 kg, respectively. Mean calf starter intakes during the 56-d study were 588, 482, and 452 g/d for calves fed 0, 10, and 20% SDWE, respectively. Mean feed efficiency ratios were 446, 318, and 231 g BW gain/kg DM intake, respectively. Fecal scores increased with increasing SDWE and were greatest in calves fed 10% SDWE. Reduced growth and intake may have been due to reduced nutrient availability, although availability of biotin did not affect intake or growth. Unless factor(s) reducing nutrient availability are identified, SDWE does not appear to be a useful ingredient in CMR formulations.

**Key Words:** calves, milk replacer, spray-dried whole egg

**54 Supplemental glutamine does not overcome the growth depression caused by soy protein concentrate in calf milk replacer.** J. K. Drackley\*, K. L. Bailey, K. S. Bartlett, and R. M. Blome, *University of Illinois, Urbana, IL*.

Glutamine may be an important fuel for intestinal cells and is less abundant in soy proteins than in milk proteins. Glutamine has been shown to lessen the growth slump at weaning in young pigs, perhaps by improving intestinal morphology and function. We tested the hypothesis that glutamine supplementation would overcome the decreased average daily gain (ADG) and altered intestinal morphology caused by milk replacer containing soy protein concentrate (SPC). Holstein calves (9 male and 1 freemartin female per treatment) were assigned to diets of 1) all-milk-replacer milk replacer; 2) SPC milk replacer; or 3) SPC milk replacer plus 1% (dry basis) L-glutamine. Milk replacers were reconstituted to 12.5% solids and were fed at 10% of body weight from d 3 to d 10 of age and at 12% of body weight (adjusted weekly) from d 10 through 4 wk of age. No starter was fed. The SPC replaced 60% of the milk protein. Glutamine was added at each feeding to the reconstituted milk replacer. All-milk and SPC replacers contained 20.9% and 19.0% CP, and 15.0% and 15.1% fat, respectively. Five calves from each treatment were slaughtered at the end of wk 4. The ADG was greater ( $P < 0.05$ ) for calves fed all milk vs. those fed SPC; glutamine did not improve ADG (0.344, 0.281, 0.282 kg/d for all milk, SPC, and SPC+glutamine, respectively). Intake of CP was adequate for all groups and did not explain the lower growth for calves fed SPC. Villus height and crypt depth did not differ among treatments for duodenum. In jejunum, villus height (713, 506, and 464  $\mu\text{m}$ ) and crypt depth (300, 209, and 229  $\mu\text{m}$ ) were greater ( $P < 0.05$ ) for calves fed all milk than for either soy group. In ileum, villus height was greater ( $P < 0.05$ ) for all milk than for either soy group (532, 458, and 456  $\mu\text{m}$ ), whereas crypt depth was greater for calves fed SPC + glutamine than for those fed SPC alone (352, 301, and 383  $\mu\text{m}$ ). Plasma urea at wk 4 was greater ( $P < 0.01$ ) for calves supplemented with glutamine than for those fed SPC alone (5.7, 4.0, and 6.6 mg/dl), suggesting that glutamine was at least partially catabolized. Supplemental L-glutamine did not improve growth or intestinal morphology of calves fed milk replacer containing SPC.

**Key Words:** Calves, Soy protein, Glutamine

**55 Prediction of water intake in young dairy calves.** J. D. Quigley, C. A. Jaynes-Kost, M. L. Miller, and T. M. Anspach, *APC Company, Inc., Ames, IA*.

Availability and consumption of water are critical to ensure adequate ruminal development and to allow early weaning of young calves. However, estimates of water intake, particularly during the first two months of life are unavailable. Therefore, our objective was to predict daily water consumption in calves fed varying combinations of calf milk replacer (CMR) and commercial calf starter (CS) for 42 to 56 d. Calves ( $n = 602$ ) were assigned to six experiments during 1999 and 2000; each experiment used different CMR formulations. Calves were primarily Holstein bull calves, although some heifers and cross-bred calves were used. Calves were typically less than 7 d of age at the start of each trial although birth date was not determined in most cases. The CS was a commercially obtained from one supplier. The CMR were experimental formulations containing 20 to 22% CP and 20 to 22% ether extract and were based on whey protein concentrate and various alternative animal proteins. Calves were fed CMR in fixed or variable amounts to weaning at 28, 42, or 56 d and were fed CS for ad libitum consumption from

d 1 or d 29 to d 42 or 56. A total of 29,714 daily observations were used to predict water disappearance (intake). Independent variables included intake of DM from CS and CMR, intake of total DM, CP, ether extract, amount of liquid CMR consumed, BW and plasma IgG concentration on d 0 of each study, daily fecal score, incidence of daily scours and veterinary treatments, day of the study, mean daily high (HDT) and low ambient temperatures, average daily humidity, solar radiation, and selected squared terms. Stepwise regression produced a full model with 23 independent variables and  $r^2$  of 0.74. A limited model ( $r^2 = 0.72$ ) was water intake (L/d) =  $1.075 + 0.00119 \times \text{intake of CS (g of DM/d)} + 3.75\text{E-}7 \times \text{CS intake}^2 + 0.023 \times \text{HDT (degrees Celsius)} + 0.00135 \times \text{HDT}^2 - 0.622 \times \text{CMR intake (L/d)} + 0.0621 \times \text{CMR intake}^2$ . Starter DM intake accounted for 63% of variation in daily water intake. Increasing maximum environmental temperature increased water intake and greater volume of milk consumption reduced water intake. Daily water intake in young calves can be predicted with reasonable accuracy.

**Key Words:** calves, water, intake

**56 The Missouri Show-Me-Select Replacement Heifer Program.** R. F. Randle\*, W. O. Herring, M. S. Kerley, R. L. Larson, K. C. Olson, V. L. Pierce, and D. J. Patterson, *University of Missouri, Columbia, MO/USA*.

The Missouri Show-Me-Select Replacement Heifer Program is an educational program that involves comprehensive guidelines for beef replacement heifer development and marketing. The specific objectives of the program are to: 1) improve existing heifer development programs through Total Quality Management; 2) provide a reliable source of quality replacement heifers; and 3) increase marketing opportunities for and add value to Missouri-raised heifers. Pre-breeding examinations are required and performed to evaluate the post-weaning to pre-breeding development phase. These examinations are scheduled at approximately 12 to 13 months of age (range 10-14 months). Examinations include reproductive tract scores (RTS), pelvic measurements, weights, and visual observations for structural soundness. These data are used to identify potential problems in development to this point, and to provide recommendations for the subsequent breeding program. Pregnancy examinations are performed on heifers prior to 120 d of gestation to determine fetal age. Herds that practice AI allow a minimum of 2 wk between AI and natural service to distinguish between AI and natural service pregnancies. The program was initiated in 1997 with 33 herds and 1,870 heifers enrolled. Participation increased 6-fold from 1997 to 1999 with 258 herds and 17,305 heifers enrolled. Pre-breeding development was evaluated based on herd cyclicality rates of 50% or greater (based on RTS). The percent of herds meeting this criteria increased 17% (48%-65%) from 1997 to 1999. The percent of herds that used estrus synchronization with at least an 80% synchronized estrus response increased 47% (17%-64%) from 1997 to 1999. The percent of herds with at least 50% synchronized pregnancy rates increased 19% (50%-69%) from 1997 to 1999. These results indicate that a coordinated on-farm heifer development program offers the potential to improve subsequent reproductive performance of replacement beef heifers and enhances the use of various reproductive procedures.

**Key Words:** Heifer Development, Reproductive Management

**57 Online extension education integrated with on-campus instruction: an advanced reproductive management course at the University of Illinois.** D. J. Kesler\*, D. J. Miller, R. L. Wallace, M. F. Hutjens, J. H. Baltz, and T. L. Steckler, *University of Illinois*.

An online Advanced Reproductive Management course (Animal Sciences 374) was created and first offered during the fall 2000 semester at the University of Illinois. The course consisted of eight online meetings and focused on dairy cattle. The course emphasized applied aspects of reproductive management and was taught at the graduate/upper undergraduate level. Students were required to have had basic instruction in reproductive biology before enrolling in the course. In addition to off-campus students, on-campus students were invited to enroll in the course. Forty-nine students enrolled in the course (10 online students and 39 on-campus students [9 graduate, 10 veterinary, and 20 undergraduate students]). On-campus students were required to attend the weekly class meeting; however, the veterinary students met as a group online with an instructor that led a discussion after class. The online students consisted of practicing veterinarians, corporate employees, and

livestock producers. Four of the students were citizens of other countries. Four of the online students requested no credit; however, one chose to receive continuing education credit. Before each online class, students completed a series of modules on CD-ROM that provided instruction on specific topics within the subject matter for the class. After each class, students completed an obligatory homework assignment that required them to apply the subject matter. Students were also obligated to participate in online dialogs, via WebBoard, throughout the semester. Students requesting graduate credit were required to review and discuss research articles online every week. In summary, teaching an advanced reproductive management course online allowed individuals to obtain cutting-edge information without leaving home and increased the quality of on-campus instruction because of the input from users of the technology. The CD-ROM is a stand-alone tool and is used for other extension/outreach education programs. The CD-ROM and the course are being revised to include two new sections (10 online meetings in future offerings) and numerous modules are being added, including information on beef cattle, for the fall 2001 offering.

**Key Words:** Online instruction, Extension education, Reproductive management

### **58 Development of a web-based scheduling program for synchronization of estrus in cattle. M.A. Dikeman\*, D.R. Strohbehn, and C.R. Youngs, Iowa State University, Ames, IA USA.**

Synchronization of estrus is a management tool for producers who perform artificial insemination in their beef and dairy cattle. Through the Iowa Beef Center, a Synchronization Planner originally developed in 1998 by Iowa State University Extension has been revised to a web-based platform that incorporates many emerging techniques for synchronization of estrus and synchronization of ovulation in cattle. The revised Synchronization Planner is still available as a stand-alone program. The major enhancements to this program include the expansion of user-selected synchronization options from seven to eleven and the addition of a cost analysis. Users supply the following inputs: desired breeding date, number of females, desired synchronization system, and estimated costs of synchronization products and AI breeding. Outputs from the Synchronization Planner include a daily work schedule that users should follow, a cost analysis and sensitivity table which illustrates the cost per pregnancy with varying expected pregnancy rates, and a list of assumptions. The web-based Extension Synchronization Planner may be found on the home page of the Iowa Beef Center (<http://www.iowabeefcenter.org>).

**Key Words:** synchronization of estrus, synchronization of ovulation, computerized scheduling

### **59 Illinois 4-H/FFA Quality Assurance and Ethics Clinic. D.W. Seibert\*<sup>1</sup>, E.N. Ballard<sup>1</sup>, J.H. Baltz<sup>1</sup>, D.B. Fischer<sup>1</sup>, D.J. Jennings<sup>1</sup>, K.H. Kline<sup>1</sup>, R.K. Knipe<sup>1</sup>, D.R. Oswald<sup>1</sup>, and T.D. Saxe<sup>1</sup>, <sup>1</sup>University of Illinois, Urbana, IL.**

The "Illinois 4-H/FFA Quality Assurance and Ethics Clinics" (QAEC) were developed in response to the unethical livestock fitting practices at many county and state fair livestock shows during the summer of 1994. This program was written and taught by the University of Illinois Extension Animal Systems Team (UI AST) and was mandatory for all youth exhibiting beef, swine, or sheep at the 1995 Illinois State Fair Junior Show (ISFJS). Dairy and horse exhibitors were included in 1996. The objectives of the program were to teach livestock exhibitors that they are involved in a food producing business and therefore responsible to 1) produce a healthy and wholesome product, 2) provide and care for their animals in a humane manner, and 3) present a positive public image regarding animal production. The clinics were approximately 1.5 hours and included oral and video presentations on 1) Benefits of Junior Shows, 2) "A Question of Ethics" video, 3) Quality Assurance of Medical Treatment, 4) Effects of Stresses on Product Quality, 5) Ethics and Animal Care of Youth Project, 6) Rules of the ISFJS, and 7) Conclusions. A training manual was developed by the UI AST for classroom instruction and included chapters on Benefits of Livestock Shows, Quality Assurance of Medical Treatment, Effects of Stress on Product Quality, and Ethical Care of Youth Animal Projects. From 1995 to 1999 some 9,914 4-H/FFA members and 3,407 parents and leaders received training. For the 2000 QAEC training a Web site was developed (<http://qaec.outreach.uiuc.edu>) which includes six subject matter modules and five specie modules. Test questions must be completed on each

module before advancing. From the Web site 777 exhibitors were certified, plus Vocational Agricultural instructors used the site for classroom teaching. The training manual has been sold to several states, and individuals from throughout the United States have logged onto the QAEC Web Site. A summary of the program, including evaluation and impact will be presented.

**Key Words:** 4-H/FFA Youth, Ethics/Quality Assurance, Web Site

### **60 Trends associated with Marbling Score, Fat Cover and, CAB Acceptance Rate. M. F. Scott\*, D. E. Wilson, and G. H. Rouse, Iowa State University.**

The objective of the study was to analyze the CAB (Certified Angus Beef™) program carcass database for trends associated with marbling score, fat cover, and CAB acceptance rate in Angus-type cattle. The CAB program carcass database is made up of over 100,000 records collected during 1989 to 1999. Steers make up 90 % of the database where 89 % of the cattle were finished in the Midwest (NE, CO, KS). The majority of the cattle (62 %) were finished in Nebraska feedyards. The CAB program overall acceptance rate was 23.4 %. Marbling score (84.0 %) is the first limiting factor for CAB acceptance of steers. A combination of marbling score and yield grade (8.3 %) and yield grade (6.1 %) alone for steers are the second and third limiting factors for CAB acceptance, respectively. The phenotypic correlation between fat cover and marbling score is nearly zero for CAB steers, yet for non-CAB steers the correlation is 0.38 ( $p < .01$ ). As yield grade increases from 2.0 to 4.0 by a tenth of a unit, marbling score increases by 0.3 % for every 1 % increase in fat cover on average for all steers. Comparing CAB steers versus non-CAB steers, marbling score increases by 0.05 % and 0.34 % for every 1 % increase in fat cover, respectively. As fat cover groups increase by 0.25 of a cm, CAB acceptance rate increases up to the 1.52-1.75 cm group, then starts to decrease for steers. When looking at marbling score by fat cover groups, CAB steers increase 0.82 % for each 0.25 of a cm increase in fat cover and for non-CAB steers, there is an increase of 5.0. Fat cover increases by 5.6 % and 14.2 % as you go from a USDA marbling score of small to modest and slight to modest, respectively. Looking at the slaughter months, there is an increase in marbling score from April to August, while fat cover remains steady. Yet CAB acceptance rate decreases from April to June then increase from June to November. Producers may be able to improve the CAB acceptance rate of their cattle if there is a clearer understanding of the relationship between traits that are included in the CAB specifications.

**Key Words:** Beef Carcass, Fat Cover, Marbling Score

### **61 Centralized ultrasound processing to evaluate beef cattle for body composition, an update for 2000. R. G. Tait, Jr\*, G. H. Rouse, D. E. Wilson, C. L. Hays, A. T. Hassen, and V. R. Amin, Iowa State University, Ames, IA.**

Advances in real-time ultrasound technology and the implementation of centralized processing has provided beef cattle seedstock producers with an accurate, faster, and less expensive method to improve body composition traits in live cattle. In 1998 a Centralized Ultrasound Processing (CUP) lab was established at Iowa State University as a research project with the American Angus Association (AAA) to transfer this technology to seedstock producers. The CUP lab research objectives are: 1) provide beef breed associations with timely, accurate, and unbiased measurements for fat thickness, ribeye area, and % intramuscular fat (marbling), 2) assist breed associations in the accurate assembly of data required to research adjustment factors and EPD for body composition from ultrasound measures, 3) provide education, training, and operational assistance for ultrasound technicians working with breeders. Adaptation by seedstock producers and breed associations has been significant. For the spring 2000 scanning season, January 1 to August 15, the CUP lab processed images on 68,335 head, consisting of 46,055 yearling bulls, 20,682 replacement heifers, and 1,598 other. The CUP lab now accepts images from two ultrasound technologies, the Aloka 500V and the Classic scanner 200. Sixty-seven field technicians submitted images to the CUP lab in 2000. Forty-seven technicians used Aloka technology to submit images on over 53,000 head of cattle, and 20 technicians used Classic technology to scan over 15,000 head of cattle. There are 14 breed associations accepting ultrasound body composition data from the CUP lab. The first full-animal model genetic evaluation for body composition EPD using AAA ultrasound data processed through CUP was accomplished in September 2000. EPD were calculated for

4,916 sires and 59,972 dams. AAA also now includes ultrasound body composition EPD on the performance pedigree of registered cattle with ultrasound information on the individual or relatives.

**Key Words:** Ultrasound, Beef Cattle, Composition

**62 Development of a quality lean index for ranking pork carcasses in a contest setting.** C. A. Stahl\*<sup>1</sup>, E. P. Berg<sup>1</sup>, W. R. Lamberson<sup>1</sup>, and T. J. Safranski<sup>1</sup>, <sup>1</sup>University of Missouri-Columbia.

A Quality Lean Index (QLI) was developed in response to the efforts of the U.S. pork industry to improve the quality of fresh pork. In the past, carcass contests in Missouri have focused on calculation of percent carcass lean, where the heaviest muscled carcass has been identified as champion. The QLI combines lean meat yield and objective quality measurements as a means of ranking carcasses based on value. The QLI utilizes traditional measurement of carcass composition (10th rib loin muscle area and backfat depth) and objective measurement of pork quality. The traits included in the QLI are percentage lean (%Lean), light intensity (L\*-value) and muscle pH (pH). The %Lean is determined by live ultrasound evaluation conducted by a certified technician. Light intensity is obtained with a HunterLab MiniScan XE Plus spectrophotometer on the cut lean surface of the ham Gluteus medius (GM) muscle. The L\*-value was chosen as a variable because of its association with consumer perceptions of fresh pork color and the potential to assign an economic value. Muscle pH is obtained with an SFK pH-Star glass tipped pH probe by insertion into the ham GM. Pork muscle pH is frequently measured in the pork industry because of its significant correlation to water-holding capacity, another economically important trait. The QLI was derived by regressing carcass value on traits commonly quantified on pork carcasses. The  $QLI = (7.76 \times \%Lean)(0.067 \times \%Lean^2)(1.9995 \times L^* - value) + (1.62 \times pH)$ . The QLI does not abandon the achievements made in carcass leanness. The positive linear coefficient for %Lean reflects the favorable relationship between %Lean and carcass value. The negative quadratic coefficient results from poor carcass quality of very heavily muscled pigs. The QLI has been well received by producers in the state of Missouri. It has been used in multiple regional contests and the 2000 MO State Fair Barrow Carcass Show. Use of this ranking procedure generates a unique educational opportunity to provide both carcass composition and objective indications of fresh pork quality.

**Key Words:** Quality Lean Index, Pork, Carcass value

**63 Critical control points for profitability in the cow-calf enterprise.** A.J. Miller\*<sup>1</sup>, D.B. Faulkner<sup>1</sup>, R.K. Knipe<sup>1</sup>, D.R. Strohbehn<sup>2</sup>, D.F. Parrett<sup>1</sup>, and L.L. Berger<sup>1</sup>, <sup>1</sup>University of Illinois, <sup>2</sup>Iowa State University.

Financial, economic, and biological data from cow-calf producers participating in the Illinois-Iowa Standardized Performance Analysis (SPA) programs were utilized. Data was collected from 1996-1999, with each herd within year representing one observation. The final database of 225 commercial herd observations (117 Iowa, 108 Illinois) ranged from 20 to 373 cows. Analyses were conducted on financial and economic cost of production data. Each observation was analyzed as the difference from the mean for that given year to eliminate environmental and cattle cycle effects. The independent variable used as an indicator of profit was return to unpaid labor and management per cow (RLM). Used as dependent variables were feed, operating, depreciation, capital, and hired labor costs, calf weight, calf price, cull weight, cull price, weaning percent, calving distribution, herd size, and investment. Family labor was used in the economic analysis. All financial factors analyzed were correlated to RLM ( $P < .10$ ) except cull weight, and cull price. All economic factors analyzed were correlated to RLM ( $P < .10$ ) except calf weight, cull weight and cull price. Results of the financial prediction equation indicate 8 measurements capable of explaining 82% of farm-to-farm variation in RLM. In both analyses over 50% of herd-to-herd variation in RLM could be explained by feed cost. In the financial regression model, depreciation cost was the second critical factor explaining 9% of variation in RLM followed by operating cost (5%). Calf weight was the fourth indicator of RLM in the financial model (5%). Investment was not a significant variable in either model, however, it was correlated to a number of the significant cost variables: feed cost, depreciation cost, and operating cost ( $P < .001$ , financial:  $P < .10$ , economic). Cost factors were more influential in driving RLM than production, reproduction,

or producer controlled marketing factors. Feed cost is the most critical control point as it was responsible for 50% of herd-to-herd variation in profit.

**Key Words:** Cow-calf, SPA, Economics

**64 Enhancing the viability of Missouri dairy farms.** S.A. Hamilton<sup>1</sup>, T.R. Rickard\*, R.L. Kallenbach, C.A. Roberts, G.J. Bishop-Hurley, and B.J. Steevens, <sup>1</sup>University of Missouri.

An aging population, environmental compliance costs, urban encroachment and a changing economic environment have resulted in a loss of 33% of Missouri dairies over the past 6 years. The dairy industry is concentrated in an area dominated by karst topography that can prohibit major herd expansion. This area has the advantage of a large forage base in a temperate climate, which is conducive to management intensive grazing (MIG). In order to curb the loss of dairies, a pilot project was initiated through a grant funded by the University of Missouri Outreach & Extension to evaluate this management practice. The purpose of the project is to work with MIG dairies over a 3-year period, initially with 12 dairies in the first year and culminating with the inclusion of 65 dairies. The project involves a holistic approach where the family and dairy business are considered as a unit in educational efforts. Parameters include financial management (economics of a MIG dairy and business decisions based on goals and budgets), forage/pasture management, and environmental compliance. Core groups of producers were formed based on geographical location. Monthly workshops are held on participating dairies to evaluate forage systems and management practices techniques. Classroom programs are held discussing family structure and business decisions. Topics are self-directed by the participating dairies to meet the needs of their critical objectives. Baseline economic data is collected from each dairy for the year preceding their involvement in the project. Average operating profit (not including P&I or capital replacement) for 1998 and 1999 was \$977 and \$927 per cow, \$662 and \$983 per acre, and \$9.19 and \$8.98 cost per cwt milk, respectively. Participants have indicated the workshops and financial information has allowed them to make effective management decisions.

**Key Words:** Management Intensive Grazing, Dairy, Economics

**65 Animal handling procedures and facilities used by dairy producers to conduct health and reproductive examinations.** A. Wagner\*<sup>1</sup> and R.W. Palmer<sup>1</sup>, <sup>1</sup>University of Wisconsin-Madison.

The objective of this study was to collect preliminary information that could be used to design a research project to define the annualized cost of different animal handling systems currently being used on modern dairy farms. Activity time recordings were collected on nine dairy farms ranging in size from 150 to 1700 cows during the summer of 2000. Dairy farms were visited when the veterinarian was conducting routine herd health and reproductive examinations. Facility features and animal handling protocols used to sort and restrain animals were observed and veterinarian activity times were recorded. Facility features used on these dairies included sort gates, palpation rails, self-locking manger stalls, and some producers used freestalls to corner animals while examinations were conducted. Five different systems, using different combinations of these features, were identified and summarized. The number of animals examined and/or treated and the veterinarian time associated with these activities were recorded and used to calculate the average veterinarian time per animal for each farm. This average veterinarian time per animal ranged from 1.37 to 3.43 minutes per animal. The capital cost of each facility feature was estimated (sort gate=\$10,000, self-locks=\$60/hole, palpation rail and extra building space=\$7000) and used to determine the expected annual capital cost for each system. Annual labor costs were estimated using \$17/trip and \$1.20/min for veterinarian time, \$20/h for herds person time and \$10/h for assistant time. The estimated capital and labor costs, of each system, were used to estimate the annual cost per herd and per cow for a standard 500-cow herd having ten percent of their animals checked each week. These standardized 500-cow annual costs per herd ranged from \$11,034 to \$16,988, or \$22.07 to \$33.98 per cow per year for the different systems identified. The advantages and disadvantages, of each animal handling system, observed or mentioned by the veterinarian or herds person were also recorded and summarized.

**Key Words:** Animal Handling, Reproductive Examinations, Facilities



**66 Early weaning calves to produce quality beef.** D. B. Faulkner<sup>1</sup>, L. L. Berger<sup>1</sup>, and N. A. Pyatt<sup>1</sup>, <sup>1</sup>University of Illinois, Urbana, IL.

There are many reasons to wean calves earlier than the traditional 205 days of age. Some conditions include: when forage supplies are low such as in a drought, when forage supplies are low quality like pure fescue pastures in mid summer, when winter feed supplies are limited and the cows need to improve body condition, and when reproductive rates for cows and/or first calf heifers are low. Other reasons include marketing cull cows that have calved on a better spring market, summer calving to reduce winter feed cost for the cow, and producing high quality beef from your calves. The National Cattlemen's Beef Association (NCBA) has identified beef quality and consistency as major problems in the beef industry. This was well documented in the National Beef Quality Audit. We have evaluated the effects of weaning time and creep feeding on cow performance, calf performance and carcass merit of the calves at slaughter. Changing these practices has a dramatic influence on calf performance in the feedlot and on carcass merit. Creep feeding research has demonstrated that source of creep feed and length of time calves receive creep feed have an influence on carcass quality grade. Little difference has been observed in feedlot performance between the different creep feeding strategies and no creep feed. It appears that calves need to be on a starch-based creep feed for about 80 days to increase quality grade. Early weaning improves quality grade dramatically and improves feed efficiency in the feedlot. We have also observed a slight increase in carcass weights of early weaned calves compared to normal weaned calves. Cows from which the calves were early weaned gain more weight than cows nursing calves. The goal of producing high quality carcasses from steers placed on feed as calves is achievable. Management of the calves to get them on a high-energy diet as early as possible is critical. This research demonstrates that we can reduce external fat and improve quality by using appropriate management strategies.

**Key Words:** early weaning, calves, beef quality

**67 Early weaning can affect rate of marbling deposition, relationship of intramuscular and subcutaneous fat deposition and feed efficiency of feedlot cattle.** L.L. Berger<sup>\*1</sup>, A.W. Wertz<sup>1</sup>, and D.B. Faulkner<sup>1</sup>, <sup>1</sup>University of Illinois-Urbana.

Early weaning calves at 90 to 150 days of age and immediately adjusting them to a high-concentrate diet has the potential to have marked effects on rate of marbling deposition, carcass composition and feed efficiency. The dogma that calf-feds will not grade does not apply to early-weaned calves fed finishing diets. Using ultrasound to measure intramuscular fat, rate of marbling deposition was twice as fast for early-weaned heifers compared to yearling heifers of the same genetics. Heifers finished as calves deposited intramuscular fat at a faster rate relative to subcutaneous fat ( $P < 0.01$ ) than yearlings. Previous research has shown that acetate is the preferred substrate for subcutaneous fat, and glucose (from propionate) is the preferred substrate for intramuscular fat. If calves never experience a high-acetate fermentation, it may be possible to increase marbling deposition without increasing backfat. Heifers finished as calves gained more efficiently ( $P < 0.01$ ) than yearlings at any given fat endpoint. The absence of a significant amount of forage in the diet of early-weaned calves has benefit 250 days later. Early-weaned calves were pair-fed to have equal rates of gain on a finishing diet or haylage diet to 200 days of age, and then fed the same diet to harvest. After 258 days on the same finishing diet, calves fed haylage during the growing phase were less efficient ( $P < 0.05$ ) than those limit-fed the finishing diet. Previous research suggests that high roughage diets can stimulate G.I. tract development that can increase maintenance requirements for months after the cattle are on a finishing diet. Using a combination of early weaning, high energy diets and cattle with the genetic potential to marble, it is possible to produce cattle that will grade 50 percent prime at 15 months of age with feed:gains of 6:1 or less.

**Key Words:** Early weaning, Carcass composition, Feed efficiency

**68 Early weaning, puberty and cow reproduction.** M.L. Day<sup>\*</sup>, J.E. Huston, and D.E. Grum, *The Ohio State University.*

The period between 3 and 6 months of age in heifer calves is characterized by dynamic maturational changes in the reproductive system. Weaning occurs at approximately 7 months of age in traditional systems, and nutritional status of heifer calves during this period is largely

determined by their dam's milk production and the available forages. Precocious puberty occurs in some of these heifers (8-25%), and is related to the rate of BW gain. In contrast, precocious puberty was observed in >50% of heifers that were weaned at approximately 3.5 months of age and fed concentrate-based diets. We conducted a study to determine if precocious puberty could be induced experimentally. Heifers ( $n=18$ ) were weaned at  $72.7 \pm 2.5$  d of age and  $114 \pm 2.9$  kg BW. Heifers were fed individually either a high energy (HE), or low energy (LE) diet through 9 months of age. Precocious puberty was induced in 7/9 heifers in the HE and 0/9 heifers in the LE treatments. Precocious puberty occurred at  $245 \pm 8.5$  d of age and  $293 \pm 10.5$  kg BW. At a similar age, non-pubertal heifers weighed  $249 \pm 11.8$  kg. Early weaning has the potential to substantially influence sexual maturation. Although the impact of this manipulation on future reproductive competence of heifer calves is unknown, it has been demonstrated that early weaning will influence reproductive efficiency of their dams during the corresponding breeding season. The impacts of the suckling stimulus and nutrition on postpartum anestrus are well documented, and withdrawal of the suckling stimulus and nutrient demands of lactation during the breeding season through early weaning should augment higher reproductive performance. In this regard, weaning calves at approximately 90 d of age resulted in an 18% increase in pregnancy rates relative to standard weaning management systems. Others have reported beneficial effects of early weaning on pregnancy rates in dams ranging from 8 to 26%. Implementation of an early weaning management system has the potential to increase reproductive performance of cows and their heifers.

**Key Words:** Puberty, Weaning, Anestrus

**69 Accelerated finishing systems for the production of high quality beef.** R. S. Wells<sup>\*1</sup>, D. B. Faulkner<sup>1</sup>, F. A. Ireland<sup>1</sup>, and M. J. Cecava<sup>2</sup>, <sup>1</sup>University of Illinois, Urbana, IL, <sup>2</sup>Consolidated Nutrition, Fort Wayne, IN.

One hundred sixty crossbred Angus x Simmental steers (90.3 7.3 kg) from University of Illinois beef herd were weaned at an average of 84 d of age and randomly placed on 1 of 4 dietary treatments: 16% CP, high corn (CHP); 13% CP, high corn (CLP); 16% CP, soyhull (SHP); 13% CP, soyhull (SLP) to determine the effects of source of energy and level of protein of early-weaned steers on performance and carcass characteristics. The experimental, growing, period was from 84 to 156 days of age. Steers were then placed on a common corn-based finishing diet until harvest at 409 days of age. No differences in ADG, G:F, or weights were observed for protein level,  $P > 0.05$ . Cattle consuming the corn based diets during the growing phase gained faster, consumed more and were more efficient than the soyhull based diets,  $P < 0.01$ . Over seventy percent of the steers consuming the soyhull based diets bloated at least once. The steers fed the soyhull based diets compensated during the finishing phase. The soyhull steers had higher ADG ( $P = 0.02$ ) and better feed efficiency ( $P = 0.006$ ). This resulted in no differences among treatments for ADG or feed efficiency when the data was summarized for the entire trial. The cattle on the corn diets during the growing period tended ( $P = 0.13$ ) to have heavier carcasses. No differences were observed for rib eye area, yield grade, back fat, liver abscesses and kidney, heart, pelvic fat;  $P > 0.05$ . There was a significant interaction for quality grade. The steers that received CHP diet had more carcasses that graded average choice and above,  $P < 0.05$ . Thirty-four percent of the steers fed the soyhull based diets had carcasses of yield grade 1,  $P = 0.06$ . The steers fed soyhull diets during the growing phase had a higher degree of variation in yield and quality grades than the steers fed the corn based diets. This data would suggest that both a high corn diet and high level of protein are required to improve carcass quality for early-weaned steers.

**Key Words:** Early-weaned, Steers, Protein level

**70 Feedlot performance and carcass traits of early weaned steers supplemented with either laidlomycin propionate or monensin.** J.D. Arseneau<sup>\*1</sup>, L.L. Berger<sup>2</sup>, D.D. Buskirk<sup>3</sup>, D.B. Faulkner<sup>2</sup>, F.L. Fluharty<sup>4</sup>, R.P. Lemenager<sup>1</sup>, S.C. Loerch<sup>4</sup>, S.R. Rust<sup>3</sup>, and M.N. Streeter<sup>5</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, <sup>2</sup>University of Illinois, Urbana, IL, <sup>3</sup>Michigan State University, East Lansing, MI, <sup>4</sup>The Ohio State University, Wooster, OH, <sup>5</sup>Alpharma, Inc., Ft. Lee, NJ.

A four-state study was conducted to compare laidlomycin propionate (LP) or monensin (MON) on feedlot performance, carcass characteristics, and liver abscesses in early weaned steers. Steer calves at four

locations (IL, n=48; IN, n=28; MI, n=24; OH, n=24) were weaned at approximately 100 d of age and randomly assigned by age and weight to one of two ionophore treatments with 2 pens/treatment; 1) 150 mg·hd<sup>-1</sup>·d<sup>-1</sup> MON for the initial 100 d on feed, and then 263 mg·hd<sup>-1</sup>·d<sup>-1</sup> MON thereafter, 2) 60 mg·hd<sup>-1</sup>·d<sup>-1</sup> LP for the initial 100 d on feed, and then 105 mg·hd<sup>-1</sup>·d<sup>-1</sup> thereafter. Similar diets were fed at each location (1.41 Mcal/kg NEg with 16% CP for the initial 100 d on feed and 14% CP thereafter). Steers were harvested when average estimated backfat thickness for all cattle at a location was 1.0 cm. No interactions (P>.10) were observed between ionophore treatment and feedlot location. Similarly, no differences (P>.10) were observed between ionophores for feedlot performance, mortality, liver abscess scores or condemned livers. Morbidity rates were not different (P>.10) between treatments (76.7%), but differed (P<.05) across locations (74.0, 100, 33.3, 100%; IL, IN, MI, OH). Carcass traits were not different between treatments (P>.10), but LP tended (P=.07) to increase dressing percentage compared to MON (60.3% vs. 59.7%). For the overall feeding period, location affected (P<.05) ADG, DMI, and G/F (1.30, 1.56, 1.69, 1.64 kg/d ADG; 5.53, 8.11, 7.85, 7.30 kg/d DMI; .23, .18, .21, .22 G/F for IL, IN, MI, and OH, respectively). Carcass quality grades were highest (P<.05) for steers fed at MI, while yield grades were numerically lowest (P<.05) for steers fed at IL. Results of this study indicate that early weaned steers fed high concentrate diets supplemented with either LP or MON will have similar feedlot performance and carcass characteristics. However, high morbidity rates in this study may have influenced performance results.

**Key Words:** Laidlomycin propionate, Monensin, Early weaned steers

### 71 Effects of milk replacer feeding rate and concentration on performance and economics in Holstein heifer calves. D. R. Catherman\*<sup>1</sup>, <sup>1</sup>Strauss Feeds, Watertown, WI.

Eighty four Holstein heifer calves (average 39.9 kg BW) were utilized in a study to evaluate the effects of milk replacer (MR) feeding rate and concentration on performance and economics. Calves were allotted to one of four treatment groups and fed a 20% protein, 20% fat MR as follows: treatment 1, 454 g/d at 12.5% solids; treatment 2, 681 g/d at 12.5% solids; treatment 3, 681 g/d at 18.75% solids; and treatment 4, 1022 g/d at 18.75% solids. Calves were weaned at 35 d and feed intake was recorded for 42 d. Water and starter grain (18% protein, 3% fat) were offered free choice from d 3. Total MR intakes were 13.8, 17.8, 17.7 and 21.0 kg for treatments 1 through 4, respectively. Total starter intakes were 32.2, 27.8, 33.8 and 26.8 kg for treatments 1 through 4. Starter intake tended to decline with increasing MR intake within a concentration, but when increasing concentration within the same feeding rate, starter intake was numerically greater. Weight gains between 0 and 21 d were lower (p<.05) for treatment 1 (7.0 kg) than for treatments 2 (9.8 kg), 3 (9.9 kg) and 4 (10.4 kg). Weight gains from 21 to 42 d were not different and averaged 10.3 kg. Overall weight gains were not different, but tended to be greater with increasing MR feeding rate and concentration (17.7, 18.9, 20.1, and 21.6 kg for treatments 1 through 4). Feed to gain ratios tended to decrease with increasing feeding rate. Feed cost per kg of gain was \$1.51 for treatment 1, \$1.69 for treatment 2 and \$1.67 for treatments 3 and 4, and were not different. Scour scores and cost and number of medical treatments were not different between groups. Based on these data, increasing MR feeding rate tended to increase weight gain. Increasing concentration from 12.5% to 18.75% within the same feeding rate resulted in slightly greater weight gains and a numerically higher starter intake. This may be related to gut fill. The data suggest that increasing concentration of MR is needed when increasing feeding rate.

**Key Words:** calves, milk replacer, feeding rate

### 72 University of Missouri Southwest Research Center Pasture-Based Seasonal Dairy. S.A. Hamilton\*<sup>1</sup>, T.R. Rickard, R.A. Crawford, R.D. Young, B.J. Steevens, and C.W. Davis, <sup>1</sup>University of Missouri.

A demonstration management intensive grazing (MIG) dairy was designed and constructed on the University of Missouri SW Research Center in 1998. The establishment of this MIG dairy was a partnering effort of dairy industry, local producers and the University of Missouri. Objectives of the grass based dairy were to evaluate the viability of a MIG operation, the use of a grass vegetative filter as a means of treating the effluent from the parlor, compare various forage species and demonstrate

a high throughput milking facility. The grazing system consists of 74 acres of improved and non-improved forages. Forty-six heifers (goal of 65) were milked the first year. Heifer breeds were Holsteins, Jerseys, and crossbreds. Local producers donated approximately one third of the heifers with the remainder being purchased. Heifers were bred to freshen in early spring (February-April) and dried off in mid-December. Milk shipped the first year was 10,853 pounds/heifer with average grain consumption of 13.3 pounds/day. Operating profit (not including P&I or capital replacement) was \$714 per heifer and \$444 per acre with cost of production \$9.70/cwt milk. The parlor, a modified New Zealand type double-10 swingline, was selected to demonstrate the simplicity in design and rapid throughput to reduce operator-milking time. Parlor design allows producers to adopt the basic concept and construct according to their needs. Effluent is collected from the parlor and deposited in two 2000-gallon tanks and spread over a two-acre paddock using a travelling gun. Holding pen waste is hand-scraped to a concrete structure. Data collection for the waste is ongoing. An advisory committee of dairy producers and extension specialists provide recommendations on forage species and research/demonstrations to be conducted. Data collected from this station can be very instrumental on the sustainability of the dairy industry in the region. Producer workshops are held to demonstrate forage management practices.

**Key Words:** Management Intensive Grazing, Dairy, Seasonal

### 73 Survey of dietary phosphorus levels in TMR-fed dairy herds. S.L. Gunderson\*, J.L. Keuning, and K.A. Erb, University of Wisconsin-Extension.

Twenty dairy herds enrolled in the AgSource DHI testing program were selected for a survey of the nutrient levels of high group and dry cow diets. Herds were located in five counties in northeast WI. Herd size ranged from 40 to 1,280 cows, with an average 246 cows. The RHA for milk, fat, and protein ranged from 9,374 to 12,403 kg/yr, 339 to 440 kg/yr, and 273 to 358 kg/yr, respectively. All herds were fed a TMR. Eleven herds were housed in tie-stalls and nine herds were housed in free-stalls. High group and far-off dry cow rations were analyzed by wet chemistry analyses for DM, CP, Ca, P, and K. Special emphasis was placed on dietary P due to the environmental consequences associated with this nutrient. High group P levels ranged from .37% to .50% averaging .46%. Far-off dry cow P levels ranged from .27% to .48% averaging .36%. Average dietary levels of CP%, Ca%, and K% were 18.5, .96, and 1.39, respectively for high group rations and 15.4, 1.00, and 1.62, respectively in the far-off dry cow rations. Fourteen of the herd owners surveyed indicated they were familiar with research showing P levels can be reduced without sacrificing milk and reproductive performance in dairy cows. High group dietary P levels decreased from an average of .52% to .47% in ten of the dairy herds over a two year period from 1998 to 2000.

**Key Words:** Phosphorus, Dairy cows, Nutrition

### 74 Illinois Lean Growth Project. Utilizing on-farm field research to develop prescription swine feeding and management regimes. D.J. Jennings\*<sup>1</sup>, G. Hollis<sup>1</sup>, D. Oswald<sup>1</sup>, E. Ballard<sup>1</sup>, R.K. Knipe<sup>1</sup>, D. Seibert<sup>1</sup>, A.P. Schinckel<sup>2</sup>, and M.D. Tokach<sup>3</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>Purdue University, West Lafayette, Indiana, <sup>3</sup>Kansas State University, Manhattan.

As profit margins tighten it becomes imperative that swine producers obtain accurate, farm-specific biological and economic performance data. Management, health, and environment account for large differences in performance, thus producers find value in moving beyond traditional book values for nutritional regimes. The objectives of the Illinois Lean Growth Project (ILGP) are to 1) demonstrate the value of farm specific amino acid levels to optimize biological and economic returns, 2) model farm specific data (ADG, feed intake, composition of gain) interfaced with economic conditions to determine optimum harvest weights, and 3) develop environmentally responsible feeding protocols that minimize urinary and fecal nitrogen excretion by reducing excess dietary nutrients. The ILGP utilizes real-time (B-mode) ultrasound (RTU) to capture farm specific data. RTU measurements can be used to accurately predict composition of growth and lysine:calorie ratios in grow-finish pigs. Determining lysine:calorie ratios ensures the right amount of lysine is provided in diets that vary in energy density. Once accurate data is established it is integrated into a model and used

to generate farm specific decision aids. A biological model for grow-finish pigs was constructed using the STELLA research dynamic modeling software. The model utilizes farm specific data, which interfaces with an adjustable economic model allowing quick access to graphical results. One example of practical use is analyzing net profit along a range of harvest weights while changes occur in cost of feed, sale prices, and overhead. The ILGP more accurately assesses composition of gain, corrects overfeeding of nutrients, and more precisely positions phase feeding. Research suggest a 12% reduction in nitrogen and phosphorus excretion when phase feeding is positioned correctly.

**Key Words:** Grow-finish model, On-farm, Swine

## **75 The effects of housing system and physical environment on post-weaning pig performance.** M. E. Larson\* and M. S. Honeyman, *Iowa State University.*

A series of six trials involving a total of 1,440 nursery pigs (average initial body weight of 6.7 kg) were conducted at two Iowa State University research farms from December 1999 to August 2000. Three small-scale hoop structures (6 × 10.8 m) were divided lengthwise to form two pens (3 × 4.5 m) per building for a total of six pens. Six pens (1.7 × 4 m) in a mechanically ventilated confinement nursery were used for comparison with the bedded hoop structure pens for each 5 wk trial. In each trial, 240 crossbred pigs were weaned 18 to 22 d of age and allotted by weight and litter to six pens found in either the hoop (n=120) or confinement (n=120) nursery facility. During the first 3 trials, heated hovers were placed in each hoop pen to provide additional heat and protection from drafts. Four commercial diets were fed to pigs in both housing systems. The pigs in hoop structures grew 23% slower ( $P < .001$ ) and consumed 23% less feed ( $P < .001$ ) and were less efficient ( $P < .001$ ) than the pigs in confinement during the first 2 wk post-weaning. Both housing systems had similar ADG ( $P > .55$ ), ADFI ( $P > .35$ ) and G/F ( $P > .10$ ) for the last 3 wk of the trial. In all seasons, the ADG and ADFI were decreased for the first 2 wk post-weaning. During the winter, the pigs in hoop structures grew 5% slower, consumed 10% less feed, but were 5% more efficient than the pigs in confinement ( $P < .05$ ). In the spring, the pigs in hoop structures grew 7% slower ( $P < .05$ ), consumed 7% less feed ( $P < .05$ ), and had similar feed efficiencies ( $P > .23$ ) as the pigs in confinement during the 5 wk trial. During the summer, the pigs in hoop structures grew 2% faster, consumed 6% less feed, and were 8% more efficient than the pigs in confinement for the 5 wk trial ( $P < .05$ ). Bedded hoop structures have not been widely studied as a cold nursery facility. It may be beneficial to wean 1 wk later in the colder months when the pigs are heavier. Further trials adjusting bedding, heat source, hovers, feeders and management may improve growth performance.

**Key Words:** Early Weaned Pigs, Hoop Structures, Growth

## **76 A two year summary of finishing-pigs' performance in hoop structures and confinement during winter and summer in Iowa.** M. S. Honeyman\*, J. D. Harmon, M. E. Larson, and A. D. Penner, *Iowa State University.*

Four trials were conducted over two years involving 2,249 pigs. Two summer trials and two winter trials were conducted from June 1998 to May 2000. The objectives were to document the performance of finishing pigs in hoop structures during summer and winter in Iowa, and to compare it with pig performance in confinement. For each trial, three groups of pigs were placed in three (9.1m × 18.3m) cornstalk bedded hoop structures (150 pigs per group). The fourth group was placed in six pens in a mechanically ventilated confinement building with slatted floors (22 pigs/pen). The pigs weighed 15.5 kg at the start of the trials and were fed corn-soy diets until weighing 115-117 kg. The pigs were scanned at 110 kg. Overall, the pigs in hoop structures ate 5% more feed, grew 3% faster and were 3% less efficient than pigs in confinement ( $P < .05$ ). Overall, the pigs in hoop structures had 7% more backfat, 5.5% smaller loineyes ( $P < .01$ ), and lower yield (1.3 percentage units) than pigs in confinement. Bedding use was 93 kg/pig in summer and 107 kg/pig in winter. In summer, pigs in hoop structures ate 3% more feed, grew 5% faster, had 12% more backfat, but did not differ in feed efficiency or loineye size compared to the pigs in confinement. In winter, the pigs in hoop structures ate 7% more feed and feed efficiency was 8% poorer, but there was no difference in growth rate, backfat thickness or loineye size compared to the pigs in confinement. The cold hoop environment encouraged the pigs to consume more feed and probably caused

the pigs to transfer feed energy from growth to maintaining body temperature. Pig mortality was lower in summer (2.8 vs. 3.7%) but higher in winter (5.0 vs. 3.1%) in hoops compared to confinement. Cull pigs were higher in the hoops during both seasons: summer (5.0 vs. 3.1%) and winter (5.7 vs. 2.0%). This may have been due to the larger hoop group size (150 vs. 22). Additional research is needed to improve feed efficiency and leanness of pigs fed in hoop structures.

**Key Words:** Finishing pig performance, bedded hoop structures, pig leanness

## **77 Composition and regulation of targeted growth of the neonate: implications for feeding systems and post-weaning management.** M.E. Van Amburgh\*, J.M. Smith, and J.N. Tikofsky, *Cornell University.*

A series of experiments have been conducted over the last four years to describe the composition and hormonal regulation of growth of Holstein calves from birth to approximately 105 kg bodyweight (BW). Diaz et al. (accepted) conducted a study to evaluate the effect of three different treatment growth rates (560, 973 and 1100 g/d, respectively) on body composition from birth to 105 kg BW, under conditions where protein intake was not limiting growth. Slaughter data from all treatments demonstrated that the energy and protein retained by the calves on this study was higher than would be described by the prediction equations of the 1989 Dairy NRC and average net deposition of CP and fat were 140 and 44, 204 and 154, and 247 and 161 g/d for treatments 1, 2 and 3, respectively. A follow-up study was conducted to evaluate the effect of source of energy on composition of growth under conditions of isocaloric and isonitrogenous intake. Three treatment diets ranged from 14.8 to 30.6% fat and 55.3 to 35.4% lactose, respectively. Intakes were isocaloric ( $P = 0.63$ ) and isonitrogenous ( $P = 0.79$ ) and rates of gain (680 to 710 g/d) were not different ( $P = 0.66$ ). However, empty body fat was greater for calves consuming more fat ( $P \leq 0.006$ ) with no change in the apparent partial efficiency of use of fat ( $P = 0.44$ ) or protein ( $P = 0.39$ ). Data demonstrate changes in body composition independent of growth rate. To better understand regulation of early growth based on age and level of nutrient supply, the ontogeny of the growth hormone (GH)/IGF-1 axis was investigated. Calves were from Diaz et al. study. Expression of the liver specific growth hormone receptor 1A was apparent in calves by 25 days of age weighing 65 kg BW. Based on circulating IGF-1, calves responded to a GH challenge at 65, 85 and 105 kg of BW in a dose dependent manner consistent with nutrient intake. Data from a follow-up study indicated that calves fed conventional rates of milk replacer did not respond in a similar manner and suggest that the GH/IGF-1 axis can be modulated early in life.

**Key Words:** calves, growth, development

## **78 Practical heifer rearing for lifetime production.** C. Park\*, *North Dakota State University.*

The future of the livestock industry (especially dairy) depends largely on a sound rearing program for replacement heifers. The success of feeding and management programs for replacement heifers must not only be measured in terms of efficiency of body growth, but, more importantly, must be assessed by the milk-yield potential of the heifer. The capacity to produce milk in turn is largely influenced by the degree of mammary development. We have studied compensatory growth using a stair-step compensatory nutrition regimen which is a rearing scheme with a unique combination of alternating dietary energy restriction and realimentation (re-feeding) phases. The basic concept of the compensatory nutrition regimen is to exploit the nature of both dietary energy restriction and the compensatory growth phenomenon in concert with one or more hormone-dependent allometric phases of mammary development (i.e., peripuberty through gestation). We have examined various models for developing dairy and beef heifers, gilts, and rats. General observations are that our multi-step feeding regimen improves not only heifer development but also growth of the mammary gland and lifetime lactation performance. While our multi-step feeding program has been proven effective for heifer rearing, a simple one-step gestation model appears to be more adaptable by livestock producers and animal scientists. Furthermore, recent research data strongly suggests that

compensatory growth established nutritionally once during late gestation improves prepartum metabolic status that is conducive to reducing postpartum metabolic disorders.

**Key Words:** Heifer development, Compensatory growth, Mammary development and lactation

**79 Regulating heifer growth by nutrition and management for economical dairy replacement systems.** A. J. Heinrichs\*, *Pennsylvania State University.*

Studies have shown that a profitable time for dairy heifers to begin their first lactation is at 22-24 mo and that BW at calving has a significant effect on first lactation milk production. Current production data would lead us to believe that calving at 22-24 months is still allowing for economically optimal milk production. A great deal is known about the nutrient requirements of calves and heifers and the growth rates to achieve the desired frame and weight of animal at calving. Four recent trials in the US have been published using various means to challenge

ADG and mammary development. These studies generally agree with the earlier data that rapid prepubertal growth is detrimental to first lactation milk production, yet current US Holsteins genetics may allow for slightly higher rates of gain (.75 kg/d) than the European studies suggest. Post pubertal heifer growth rates are limited primarily by body condition. It is important to remember that the protein requirement of the ruminant is a combination of the needs of the rumen microorganisms and the host animal itself. The concentration of protein necessary to ensure maximum intake and production will remain relatively constant after the stage has been reached at which the potential protein utilization is met from microbial and basal protein. We must continue to refine our knowledge of economical systems that result in unlimited production potential of the mature dairy animal. Economical means of achieving well grown heifers in a timely fashion, must be the primary concern in the future. This review will look at much of the current literature on growth and major nutrient requirements of the dairy calf and heifer as well as point out areas where more research is needed.

**Key Words:** Dairy heifer, Growth, Requirements

**GRADUATE STUDENT COMPETITIVE RESEARCH PAPERS**  
**M.S. Division**

**80 Effect of level and source of nitrogen and minerals on water utilisation patterns in growing pigs.** M.I. Shaw\*<sup>1,2</sup> and J.F. Patience<sup>1</sup>, <sup>1</sup>*Prairie Swine Centre, Inc., Saskatoon, Canada,* <sup>2</sup>*University of Saskatchewan, Saskatoon, Canada.*

Concerns relating to the use of water resources by the livestock industry, combined with the rising cost of storing, hauling and spreading manure have resulted in greater interest in defining more precisely the drinking water consumption of pigs. In particular, little information is available on the impact of diet composition on *ad libitum* water intake. The objective of this experiment was to investigate the response of water utilisation patterns in 30-kg pigs to diets differing in source and level of nitrogen and minerals. A total of 54 crossbred barrows (3 replicates of 18 pigs each) were placed on a control diet for 8 days; thereafter, each pig was randomly assigned within replicate to one of six diet treatments for an 8-day experimental period. The control diet was based on soyabean and canola meals at 18.5% crude protein, and was compared to either high- (22.5% CP) or low- (14.5% CP) protein diets. The remaining diets were formulated at 18.5% CP: the fourth diet based on meat and bone meal as the protein source, a fifth similar to the control but with a mineral level equal to that of the animal protein-based diet and a sixth diet similar to the control but with elevated calcium (1.25% vs 0.71%), phosphorus (1.00% vs 0.60%) and salt (0.75% vs 0.40%) to attain a high mineral level. Water consumption and spillage were measured on d 6, 7 and 8 of the control period and on d 6, 7 and 8 of the experimental period. Urine and faeces were collected quantitatively on d 6, 7 and 8 during each period, and blood samples were taken once daily on d 6 and 7 of each period. Treatments had no statistically significant effect on water intake or urine output ( $p > 0.10$ ). Similarly, plasma angiotensin II did not differ among treatments ( $p > 0.10$ ). In conclusion, dietary treatment had no impact on water consumption, urine output or angiotensin II level in the blood.

**Key Words:** Swine, Water, Nitrogen, Urine, Angiotensin

**81 Dexamethasone treatment and increased growth in neonatal piglets.** J.S. Seaman\*<sup>1</sup>, T.J. Safranski<sup>1</sup>, R.L. Matteri<sup>2</sup>, and J.A. Carroll<sup>2</sup>, <sup>1</sup>*University of Missouri, Department of Animal Science,* <sup>2</sup>*Animal Physiology Research Unit, Agricultural Research Service, USDA, Columbia, MO.*

We have previously reported that dexamethasone (Dex) treatment at birth increases growth in neonatal piglets. The objective of the present study was to further evaluate effects of Dex treatment at birth on growth in piglets. Thirty-four crossbred piglets were assigned according to birth weight and sex to receive either sterile saline (Control; n=11 boars and 4 gilts) or Dex (1 mg/kg body weight; n=10 boars and 9 gilts) i.m. within 1 hr of birth. Body weights were recorded weekly and on d 18, at which time all piglets were sacrificed for blood and tissue collection. Birth weights ( $1.483 \pm .32$  kg) did not differ between Dex and Control piglets ( $P > .15$ ), however, boars ( $1.55 \pm .06$  kg) were heavier at birth than gilts ( $1.37 \pm .10$  kg;  $P < .05$ ). Overall average daily gain

(ADG) was increased ( $P < .05$ ) in Dex piglets ( $.227 \pm .053$  kg/d) compared to Controls ( $.187 \pm .055$  kg/d). There was no difference ( $P > .33$ ) in birth to week 1 ADG between Dex and Control piglets. Dex increased ADG ( $P < .02$ ) from birth to 2 weeks compared to Controls. The greatest increase in ADG occurred from week 1 to week 2 ( $P < .004$ ) in Dex piglets ( $.245 \pm .053$  kg/d) compared to Control piglets ( $.190 \pm .040$  kg/d). Serum concentration of IGF-1 was influenced by treatment ( $P < .04$ ). In Dex piglets, serum concentration of IGF-1 was increased by 17.3% ( $P < .04$ ) compared to Controls. There was no difference in serum IGF-2 concentrations between Dex and Control piglets ( $P > .82$ ). For serum GH there was a treatment x sex interaction ( $P < .04$ ). Dex decreased ( $P < .02$ ) serum concentration of GH by 51% in boars compared to Control boars, while no effect was observed in gilts. Based on the results of the present study and the previous report, Dex treatment at birth enhances growth in piglets during the first 18 d following birth. Further research is needed to determine if this increase is maintained throughout the weaning, growing and finishing stages.

**Key Words:** Dexamethasone, growth, piglets

**82 Effect of dietary Bacillus subtilis Ferm (BP-3418) on odor and nutrient excretion in pigs.** J. S. Knott\*, G. C. Shurson, and M. H. Whitney, *University of Minnesota, St. Paul, MN.*

A total of 18 barrows and 32 Deep Pit Simulator Models (DPSM) were used to evaluate the effect of dietary *Bacillus subtilis* Ferm (BP-3418) on hydrogen sulfide, ammonia, odor and nutrient excretion in a 15-wk study. Feces and urine were collected daily from 8 pigs housed in metabolism crates and equally added to each of 4 DPSMs corresponding to crate. A four phase feeding program was used to compare a conventional corn/soybean meal control diet with and without 0.5% BP-3418 in direct replacement of corn. At the end of each 4-wk period N and GE balance was determined. Weekly collections of hydrogen sulfide (H<sub>2</sub>S) and ammonia (NH<sub>3</sub>) were measured and analyzed using a Jerome<sup>TM</sup> meter and titrating air bubbled through a boric acid solution by sulfuric acid, respectively. Every 5 wks, air samples were collected and analyzed by human panelists utilizing an olfactometer for odor detection threshold (ODU), intensity and hedonic tone. Dietary addition of BP-3418 had no significant ( $P > .10$ ) effect on GE and N retention or excretion, or urinary and fecal N concentrations. During wks 4, 5, 6, 7, 13, and 14, there was a ( $P < .05$ ) reduction in H<sub>2</sub>S emissions from manure originating from pigs fed BP-3418. NH<sub>3</sub> concentration was not affected by dietary treatment with the exception of wk 13, when pigs fed the control diets had a ( $P < .10$ ) lower ammonia concentration. Odor characteristics (ODU, intensity, and hedonic tone) were not affected by dietary treatment. Upon completion of the 15-wk trial, slurry samples from each of the DPSMs were collected and analyzed for N, P, and K. N and P concentration of the slurry did not differ between treatments ( $P > .10$ ). Concentration of K in DPSMs containing manure originating from pigs fed BP-3418 was higher than manure from pigs fed the control diet ( $P < .10$ ). In conclusion, BP-3418 appears to be effective in reducing

H<sub>2</sub>S emissions but not NH<sub>3</sub>, odor emissions, offensiveness, intensity, or nitrogen and energy retention in this study.

**Key Words:** *Bacillus subtilis* Ferm, Odor, Swine

**83 Feeding degermed, dehulled corn to reduce nutrient excretion and improve performance in pigs.** A.J. Moeser\*, I.B. Kim, E. van Heugten, and T. van Kempen, *North Carolina State University, Raleigh, NC.*

Two experiments were designed to assess the feeding value and potential environmental benefits of feeding a low fiber by-product originating from the corn dry milling process (degermed, dehulled corn, DGDH) to pigs. Twelve 27-kg barrows were used in Exp. 1 to evaluate nitrogen (N) and energy digestibility of DGDH compared to regular corn. Animals were individually housed in metabolism cages in which feces and urine was collected. Two diets were formulated to contain either 96.4% of DGDH or regular corn plus supplemental vitamins and minerals. Chromic oxide was used as an indigestible marker. Digestibilities of DM, N, and energy were greater in DGDH (93.4, 89.1, and 92.9%, respectively) compared to regular corn (84.9, 67.9, and 83.5%, respectively) ( $P < .01$ ). Overall, a 56 and 39% reduction in DM and N excretion, respectively, was observed. In Exp. 2, 96 nursery pigs with initial BW of 8.8 kg, blocked by weight and gender, with 4 pigs/pen, were used in a 28-d growth performance study. Two starter diets were formulated to contain either DGDH (56%) or regular corn (58%) as the major grain source. Diets were formulated on a ME and digestible lysine basis to meet NRC requirements for this weight category of pig. At the end of the study, 24 pigs (1 from each pen) were slaughtered and gastrointestinal tract measurements were taken. Daily growth rates of pigs were the same between diets (0.64 kg/d). Feeding DGDH to pigs resulted in a 4% improvement in feed efficiency over regular corn ( $P < .05$ ). The full intestinal tract weight of pigs fed DGDH tended to be 6% lighter ( $P=.07$ ), likely due to a trend towards 10% less gutfill and 4% less intestinal mass. Results from these trials suggest that corn processed to remove poorly digestible fiber fractions provides more digestible nutrients than regular corn. As a result, DGDH reduces fecal and N excretion, thus providing a novel approach for reducing waste production.

**Key Words:** Nutrient excretion, Digestibility, Pigs

**84 Effect of uncoupling protein 1 knockout in mice divergently selected for heat loss.** T.G. McDanel\*<sup>1</sup>, M.K. Nielsen<sup>1</sup>, and J.L. Miner, <sup>1</sup>*University of Nebraska.*

Uncoupling protein 1 (UCP1) is specific to brown adipose tissue (BAT) and mediates thermogenesis by dissipating the proton gradient. Uncoupling protein 2 (UCP2) is expressed ubiquitously and may have a role in thermogenesis. The objective of this study was to determine if the difference in heat production/loss between two lines of mice (MH = high and ML = low) developed by divergent selection depends on UCP1. A UCP1 knockout transgene, kindly provided by L. Kozak, was backcrossed into the MH and ML lines by speed congenics; the resulting lines were designated KH and KL, respectively. Homozygous UCP1-null (-/-) KH (23 male and 16 female) and KL (17 male and 14 female), and UCP1-normal (+/+) KH (8 male and 10 female) and KL (10 male and 10 female) mice were used. Heat loss was measured by direct calorimetry between 10 and 12 wk of age. Mice were killed at 13 wk of age, selected tissues were weighed, and RNA was extracted. Knockout of UCP1 did not affect heat loss ( $P > 0.6$ ). Heat loss was greater for KH (166.0 kcal\*kg<sup>-0.75</sup>\*d<sup>-1</sup>) than for KL (126.4 kcal\*kg<sup>-0.75</sup>\*d<sup>-1</sup>;  $P < 0.05$ ) regardless of UCP1 allele. Weight of BAT for KH (-/-), KL (-/-), KH (+/+), and KL (+/+) was 0.36, 0.28, 0.18, and 0.17 g, respectively (effects of line, UCP1 allele, and the interaction,  $P < 0.05$ ). Epididymal adipose tissue weight tended to be greater in KH (-/-) and less in KL (-/-) compared to KH or KL (+/+;  $P < 0.09$ ). Retroperitoneal adipose tissue weight was greater in (-/-) lines ( $P < 0.06$ ). Heart weight was greater for KH than for KL ( $P < 0.01$ ). Concentration of UCP mRNA was measured by ribonuclease protection assay. Absence of UCP1 did not affect UCP2 mRNA concentration in heart or epididymal white adipose tissue. We conclude that the difference in heat production/loss between MH and ML lines is not dependent on UCP1.

**Key Words:** Brown Adipose Tissue, Thermogenesis, Uncoupling Protein

**85 Effects of high linoleic safflower seed supplementation for gestating ewes on fat deposition in lambs.** H. B. Encinias\*, A. M. Encinias, M. L. Bauer, and G. P. Lardy, *North Dakota State University, Fargo.*

Lamb survival during periods of cold weather can be a problem in northern climates. Effects of prepartum, high linoleic safflower supplementation for ewes on brown fat deposition in lambs were investigated in a completely randomized design. Twenty ramboillet cross ewes (83.5 1.9 kg BW) were fed isocaloric and isonitrogenous diets containing either 1.9 (LF) or 4.6% (HF) dietary fat beginning 57.1 1.4 d prepartum. Rolled safflower seeds (32.8% fat; 74.6% linoleic acid) were supplemented in HF. Safflower meal was used as protein source in LF supplement and energy was balanced with corn. Basal diet consisted of 37.5% grass hay, 37.5% alfalfa hay, and 25% corn silage (DM basis). Ewes were weighed and blood samples were collected every two weeks and at parturition, and analyzed for plasma NEFA and glucose. At parturition, lambs were weighed and blood was sampled for plasma NEFA and glucose analysis. One lamb from each ewe was selected randomly to be slaughtered. Perirenal (PR) and pericardial (PC) brown fat was excised and weighed, and carcass was frozen for compositional analysis. Rectal temperatures of live lamb were measured 0, 2, 4, 6, 12, 24, and 48 h and blood was sampled 24 and 48 h postpartum. Ewe BW increased to 92.5 0.5 kg ( $P < 0.001$ ) and basal diet dry matter intake decreased from 1.6 to 1.2 0.1 kg ( $P < 0.001$ ) over the trial. Prepartum ewe NEFA exhibited a treatment by period interaction ( $P = 0.004$ ) while NEFA at lambing was similar (1.1 0.2 mEq/L;  $P = 0.55$ ). Lamb birth BW (5.3 0.1 kg;  $P = 0.51$ ) and NEFA were not different ( $P = 0.48$ ). Lamb rectal temperatures exhibited a treatment by time interaction ( $P = 0.03$ ). Brown adipose weights were similar ( $P > 0.11$ ) among treatments (PR = 33.0 1.4 g; PC = 7.2 0.4 g), as were lamb carcass constituents (69.5 0.4% fat; 15.1 0.7% CP; DM basis). Prepartum supplementation with high linoleic safflower seed does not seem to affect lamb birth weight, perirenal or pericardial fat mass, carcass constituents, rectal temperature, or plasma NEFA.

**Key Words:** Safflower, Ewes, Brown Fat

**86 Outcomes assessment for introduction to animal science - subjective and objective measures and the effects of student demographics.** M. A. Deppe\*<sup>1</sup>, G. F. Jones<sup>1</sup>, K. J. Stalder<sup>2</sup>, and A. E. Ramer<sup>1</sup>, <sup>1</sup>*Western Kentucky University, Bowling Green, KY,* <sup>2</sup>*University of Tennessee, Knoxville, TN.*

Outcomes assessment is the process of determining student progress in a class or academic program. Since student perceptions are crucial to subjective evaluations, a more objective means of assessment may be useful as well. Students, (n=162), from three freshman-level university introductory animal science sections were given subjective and objective evaluation instruments on the first and last day of class. Students self evaluated themselves for competencies on each of forty-nine course outcomes using a scale of 1-100. Twenty-one demographic questions were also answered. Students were given the same 50-question examination following completion of the subjective assessment on the first and last day of class. Dependant variables were average beginning assessment (ABA), average ending assessment (AEA), average improvement (AI), average percent improvement (API), initial test score (ITS), final test score (FTS), test improvement (TI), percent test improvement (PTI) and final average (FA). Independent variables included gender, student type, animal experience, environment, age, activities and hours completed at Western Kentucky University. Gender approached significance for ABA ( $P=.11$ ), AI ( $P=.13$ ), FTS ( $P=.06$ ) and TI ( $P=.15$ ), but did not show significant differences for AEA and PTI. Environment influenced AI ( $P=.04$ ) and approached significance for FTS ( $P=.14$ ). Number of hours currently held at the university approached significance for AEA ( $P=.09$ ). The API was 140 and the PI was 92. AI was negatively correlated to ABA (-.83), but TI was not significantly related to ABA (.08). PTI had little association with ABA, AEA or AI (.01, .08 and .06 respectively). ABA, AEA and AI were not significantly correlated with PTI, TFS or FA.

**Key Words:** Outcomes assessment, Students, Evaluations

**87 Characterization of the porcine interferon regulatory factor 6 (IRF6) gene: cDNA cloning, expression analysis and chromosomal localization.** C. R. Farber\*, N. E. Raney, and C. W. Ernst, *Michigan State University, East Lansing, MI, USA.*

Representational difference analysis (RDA) was used to isolate genetic markers from pigs differing in loin muscle area. A BLAST search revealed that RDA fragment MSURDA79 was homologous to human, mouse and sheep interferon regulatory factor 6 (IRF6). IRF6 is a member of the interferon regulatory factor family of transcription factors, which regulate the function of multiple interferon genes in a host of molecular mechanisms. Three porcine IRF6 clones were isolated from pig brain cDNA using PCR primers designed from MSURDA79 and human IRF6 mRNA sequence, and 3 rapid amplification of cDNA ends (RACE). The coding region was 92%, 91% and 90% homologous to sheep, human and mouse IRF6, respectively. RT-PCR analysis using pig specific primers amplifying a 195 bp fragment of exons 6 and 7, revealed the presence of transcripts in pig aorta, brain, duodenum, ileum, jejunum, liver, skeletal muscle and uterus. Northern blot analysis confirmed expression of 2.5-kb and 2.0-kb transcripts in pig ileum and identified expression in kidney tissue. Human IRF6 has been localized to human chromosome (HSA) 1q32.3-q41. This region of HSA1 is conserved on pig chromosome (SSC) 9q23-qter. Physical mapping, using a pig-rodent somatic cell hybrid panel, placed IRF6 in the interval of SSC9q11-q26 (risk of error less than 0.1%). Radiation hybrid (RH) mapping using the INRA-Minnesota RH panel (IMpRH) showed significant linkage between IRF6 and two markers on SSC9, SW749 (LOD=14.72) and SW1651 (LOD=14.43). To further confirm this localization, a single-stranded conformational polymorphism (SSCP) was identified in IRF6. The PiGMap reference families were genotyped and linkage analysis was conducted using the two-point option of CRI-MAP 2.4. IRF6 exhibited significant linkage with SW749 on SSC9 (LOD=5.42,  $\theta=0.00$ ). To our knowledge this is the first reported isolation of a gene sequence using RDA. Further analysis of IRF6 is warranted as a potential candidate gene for production traits in pigs.

**Key Words:** IRF6, gene expression, gene mapping

**88 Ranch of origin management factors affecting the occurrence of respiratory tract lesions in feedlot steers at harvest.** N. K. Grathwohl\*, W. B. Epperson, B. J. Johnson, and S. W. Fausti, *South Dakota State University.*

The impact of ranch of origin management on the occurrence of respiratory tract lesions (RTL) at harvest was investigated using data from 709 steers enrolled in South Dakota State University's Calf Value Discovery Program (1998 and 1999). Preliminary observations from 1998 data suggested ranch of origin management was associated with the occurrence of RTL in feedlot steers at harvest. Groups of at least five steers from 82 owners entered the feedlots in November 1998 and November 1999. Producers completed a survey at feedlot entry, which described health and management practices at the ranch of origin. At feedlot entry, steers were vaccinated, ear tagged and weighed. Steers were marketed on a carcass basis when acceptable weight and finish standards were attained. At harvest, lungs were examined for evidence of RTL. Steers were assigned a numerical lung score based on the severity of the lesions (0=no lesions, 17=most severe). Steers with lung scores of  $\geq 7$  were classified as having RTL. Logistic regression of SAS was used to model factors affecting occurrence of RTL at harvest. Odds ratios (OR) were computed as estimates of risk. Cattle vaccinated with a modified-live viral vaccine at the ranch of origin prior to feedlot entry had reduced occurrence of RTL ( $P<.05$ , OR=.56) compared to steers not vaccinated. Steers weaned for  $\geq 30$  days prior to feedlot entry had a 1.59 OR of RTL compared to steers not weaned ( $P<.05$ ). Steers known to be treated for respiratory illness in the feedlot had a 2.21 OR ( $P<.05$ ) of having RTL at harvest compared to steers not treated. Year and days on feed also influenced the occurrence of RTL at harvest ( $P<.05$ ). These data suggest ranch of origin management factors impact the occurrence of RTL in feedlot steers at harvest. A more thorough understanding of these factors could reduce the incidence of RTL and improve feedlot performance and carcass quality at harvest.

**Key Words:** Beef Cattle, Lung Lesions, Health

**89 Supply of essential amino acids to the small intestine in cattle consuming restricted amounts of forage plus supplementary undegradable intake protein.** E. J. Scholljegerdes\*, J. Gould, B. W. Hess, and P. A. Ludden, *University of Wyoming, Laramie, Wyoming/USA.*

Eight Angus  $\times$  Gelbvieh heifers (avg. initial BW = 594 kg  $\pm$  44.4 kg) fitted with ruminal and duodenal cannulae were used in a 4  $\times$  4 Latin square double cross-over designed experiment to determine the intestinal supply of essential amino acids (EAA) in heifers consuming restricted amounts of forage plus an undegradable intake protein (UIP) supplement. Heifers were fed chopped (2.54 cm) bromegrass hay (6.7% CP, 68% NDF) at 30, 55, 80, or 105% of maintenance. Heifers fed below maintenance were given increasing amounts of UIP supplement (6.8% blood meal, 24.5% feather meal, and 68.7% fish meal; DM basis) in an effort to provide an equal quantity of EAA to that of the 105% of maintenance diet. Experimental periods were 21 d in length with 17 d of adaptation followed by 4 d of intensive sample collection. True ruminal OM and NDF digestion (g/d) declined linearly ( $P < 0.01$ ) with decreasing intake, but did not differ ( $P \geq 0.31$ ) among treatments when expressed as a percentage of intake (54.2  $\pm$  2.0% and 60.7  $\pm$  2.6%, respectively). True ruminal N digestibility did not differ ( $P = 0.40$ ) as intake increased from 30 to 105% of maintenance intake. Non-microbial EAA flow (g/d) was unaffected ( $P = 0.07$ ) by treatment and averaged 182.8  $\times$  19.6 g. As a result of a linear increase ( $P < 0.01$ ) in microbial EAA flow from 123.8 to 280.0 g/d, total EAA flow to the duodenum increased linearly ( $P < 0.01$ ) from 283.9 to 477.9 g/d as intake increased from 30 to 105% of maintenance. Microbial EAA profile did not differ ( $P = 0.63$ ) across treatments. Flow of EAA to the small intestine increased with supplementary UIP; however, total EAA flow to the small intestine decreased because bacterial EAA flow declined with intake restriction. We conclude that dietary supplementation of UIP can be used to balance supply of EAA, as long as there is an adjustment for the decreased microbial EAA flow associated with beef cattle consuming restricted amounts of forage.

**Key Words:** Restricted Intake, Amino Acids, Undegradable Intake Protein

**90 The optimum valine:lysine ratio in nursery diets to maximize growth performance in weanling pigs.** B. W. James\*, R. D. Goodband, M. D. Tokach, J. L. Nelssen, J. M. DeRouche, and J. C. Woodworth, *Kansas State University, Manhattan.*

The objective of this 21-d growth assay was to determine the optimal true digestible valine:lysine ratio in diets to maximize growth performance. A total of 210 pigs (initially 8.9 kg and approximately 28 d of age, PIC C22  $\times$  327) were blocked by weight and allotted randomly to seven dietary treatments. Each treatment had six replicates and 5 pigs per pen. Corn, soybean meal, and spray-dried whey were analyzed for complete amino acid profiles prior to diet formulation. Crystalline L-valine was added to the 1.12% true ileal digestible lysine (TID) basal diet (14.2% CP) to provide 0.56, 0.616, 0.672, 0.728, 0.784, and 0.84% TID valine (50 to 75% of lysine). The negative control diet (Neg) contained less L-lysine HCl to provide 1.02% TID lysine and 0.84% TID valine to ensure that lysine was not above the pigs requirement in the experimental diets. Pigs fed the negative control diet gained less ( $P<0.03$ ) from d 0 to 21 when compared with pigs fed the diet containing 0.84% TID valine with 1.12% TID lysine. Feed efficiency improved (quadratic,  $P<0.01$ ) from d 0 to 7 and d 7 to 14 with increasing dietary valine. Increasing valine increased (quadratic,  $P<0.01$ ) ADG and ADFI from d 0 to 7, d 7 to 14, and d 14 to 21. Overall, ADG and ADFI were maximized at the 0.672% TID valine. Feed efficiency was optimized for pigs fed diets formulated to contain 0.728% TID valine. The broken line model predicted a requirement of approximately 0.616 to 0.672% TID valine. These results suggest that the optimum TID Val:Lys ratio to maximize growth performance of 9 to 17 kg pigs is approximately 60% of lysine and is not above the requirement estimated (68% of TID lysine) by NRC (1998).

Item	% Val:Lys						
	50	55	60	65	70	75	Neg
Days 0 to 21							
ADG, g	203	341	380	379	376	366	330
ADFI, g	459	665	738	711	708	710	665
G:F	0.44	0.51	0.51	0.53	0.53	0.52	0.50

**Key Words:** Valine, Lysine, Weanling Pigs

**91 Effect of phytase on plasma metabolites in pigs after a meal.** S. B. Williams\*, J. O. Matthews, T. D. Bidner, and L. L. Southern, *LSU Agricultural Center, Baton Rouge, LA.*

A feeding challenge experiment was conducted with barrows (eight per treatment; average BW of 53 kg) to determine the effect of phytase on plasma glucose, NEFA, insulin, and alpha-amino nitrogen concentrations. Barrows were assigned to either a corn-soybean meal (C-SBM) diet or C-SBM + 500 FTU of phytase per kilogram of diet. Diets provided 0.77% total Lys and met all other nutrient requirements for growing pigs. In the diet with no phytase Ca and available P were 0.50% and 0.19%, respectively, and in the diet with phytase Ca and available P were decreased by 0.12%. A catheter was surgically inserted into the anterior vena cava of each pig 6 d before the start of the feeding challenge. The barrows were penned individually in metabolism crates and the experimental diets were fed for 3 d before the feeding challenge was conducted. The pigs were held without feed for 16 h and blood samples were obtained at -60, -30, and 0 min before the pigs were fed (2% of BW). Blood samples were then collected at 10, 20, 30, 40, 50, 60, 75, 90, 105, 120, 150, 180, 210, 240, 270, and 300 min post-feeding. Plasma samples were analyzed for glucose, NEFA, insulin, and alpha-amino nitrogen concentrations. Plasma glucose concentrations and glucose area under the curve were increased ( $P < 0.05$ ) by 500 FTU of phytase. Phytase did not affect ( $P > 0.10$ ) NEFA concentrations, clearance, or half-life. Insulin concentrations were increased ( $P < 0.05$ ) by phytase, but insulin area under the curve was not affected ( $P > 0.10$ ). Phytase did not affect ( $P > 0.10$ ) insulin:glucose. Plasma total alpha-amino nitrogen concentrations were increased ( $P < 0.02$ ) by the addition of 500 FTU of phytase. However, total alpha-amino nitrogen area under the curve was not affected ( $P > 0.10$ ) by phytase. There were no treatment by time interactions ( $P > 0.10$ ) in the data. These data indicate that 500 FTU of phytase increases plasma glucose, insulin, and total alpha-amino nitrogen concentrations following a meal.

**Key Words:** Pig, Phytase, Plasma Metabolites

**92 Effect of a step-up or step-down ractopamine sequence for late-finishing pigs.** C.T. Herr\*, D.C. Kendall, K.A. Bowers, S.L. Hankins, T.E. Weber, A.P. Schinckel, and B.T. Richert, *Purdue University, West Lafayette, IN.*

One-hundred sixty pigs, 80 barrows (B) and 80 gilts (G) (initial BW=71.9 kg) were allotted by sex and weight to evaluate the effect of feeding a constant or a phase feeding treatment (trt) of varying ractopamine (RAC) levels on growth performance and carcass traits. Pigs were fed one of four dietary trts ad libitum for 42 days. Treatments were as follows: 1) Control diet containing no RAC wk 0-6; 2) Step-down RAC sequence: 20 ppm RAC wk 1 and 2; 10 ppm RAC wk 3 and 4; and 5 ppm RAC wk 5 and 6; 3) Step-up RAC sequence: 5 ppm RAC wk 1 and 2; 10 ppm RAC wk 3 and 4; and 20 ppm RAC wk 5 and 6; 4) Constant RAC, 11.6 ppm wk 0-6. A 19.6% CP diet, 1.2% lys, and an 18.5% CP diet with a 1.1% lys level were fed to G and B, respectively. Overall ADG was increased (1.05 vs .95 kg/d;  $P < .05$ ) for pigs fed RAC compared to the control. Pigs fed the step-up RAC had an increase in overall ADG (1.07 vs 1.01 kg/d;  $P < .05$ ) compared to step-down RAC. The step-up RAC trt had decreased overall ADFI (2.73 vs 2.97 kg/d;  $P < .05$ ) compared to the control trt. The step-up and constant trts had lower overall gain:feed compared to the step-down (.39 vs .36;  $P < .05$ ) and control pigs (.39 vs .32;  $P < .05$ ). An increase in slaughter weight (116.9 vs 111.9 kg;  $P < .05$ ) was observed for the step-up and constant trts compared to the control, and all pigs fed RAC had a higher hot carcass weight (84.9, 87.7, 90.8, 90.0 kg; trt 1-4, respectively,  $P < .05$ ). A reduction in fat depth (19.8 vs 17.0 mm;  $P < .05$ ), and an increase in % lean (55.0 vs 53.0%;  $P < .05$ ) was observed for pigs fed the step-up and constant trts compared to the step down RAC and control trt. All pigs fed RAC had an increase in loin depth (6.43 vs 5.86 cm;  $P < .05$ ) and had a higher carcass yield (77.27 vs 75.85%;  $P < .05$ ) compared to the controls. Constant and step-up trts yielded similar pig growth and carcass characteristics. The step-down program had reduced growth and carcass characteristics compared to the step-up and constant programs.

**Key Words:** Pigs, Finishing, Ractopamine

## GRADUATE STUDENT COMPETITIVE RESEARCH PAPERS Ph.D. Division

**93 Defining the molecular weight cut-off for in vitro digestible protein assay by comparison of the size distributions of the homoarginine-labeled soluble peptides of meat and bone meal digested in vitro and in vivo.** Y.R. Qiao\* and T.A. van Kempen, *North Carolina State University.*

To study the difference between an in vitro digestion and ileal digestion, three guanidinated meat and bone meals (GMBM) with conversion of lysyl to homoarginyl of 74.35.6% were used in three digestion treatments, namely in vitro (VIT), in vivo (VIV) and in vitro plus in vivo (VITVIV). VIT was in vitro digestion with an in vitro method designed to maximally digest meat and bone meal with pepsin and pancreatin. VIV was in vivo digestion of the GMBM. VITVIV was in vivo digestion of the VIT treated GMBM. The in vivo treatment was done on ileal fistulated pigs in a 6x6 Latin square design. Post-digestion samples were centrifuged at 7,000 g and the dried supernatants were pooled and re-suspended in an aqueous solution of 0.1% trifluoroacetic acid and 35% methanol. After filtration at 0.45  $\mu$ m, the filtrate was used for size-exclusion chromatography on a G2000SWXL column. Calibration was made with thirteen peptides with molecular weights up to 14 kD. All the eluted fractions were analyzed for homoarginine. Though the system could elute soluble peptides above 14 kD, no homoarginine-containing peptides were found in fractions with peptides larger than 5 kD. Of the total homoarginine eluted, 12.03.1%, 0.10.1% and 0 appeared in fractions of between 1 kD and 5 kD for VIT, VIV and VITVIV, respectively. The percent homoarginine in fractions of between 1 kD and 5 kD in VIT was higher than in VITVIV ( $P < 0.01$ ), suggesting effects of intestinal peptidases on digesting the peptides coming from VIT digestion. VIV and VITVIV were not different ( $P=0.97$ ) in homoarginine distribution, suggesting VIT treatment did not improve in vivo digestion and hence digestion in vivo was not limiting for GMBM utilization. The study shows that 1 kD as the molecular weight cut-off to fractionate the digestible from the indigestible is too low and may partly explain the underestimated

in vitro digestibility of feed proteins. The molecular weight cut-off can be safely increased to 5 kD.

**Key Words:** Meat and bone meal, Digestion, Molecular weight cut-off

**94 Economic analysis of calf- versus yearling-finishing.** D. J. Jordon\*<sup>1</sup>, T. J. Klopfenstein<sup>1</sup>, C. T. Milton<sup>1</sup>, R. J. Cooper<sup>1</sup>, T. L. Scott<sup>1</sup>, G. E. Erickson<sup>1</sup>, and R. T. Clark<sup>1</sup>, <sup>1</sup>*University of Nebraska.*

Four yr of data were summarized comparing the economics of calf- and yearling-finishing systems from 1995-1998. Steers were assigned to one of two yearling treatments or calf-finishing. For yearling treatments, steers grazed low-quality winter forages with or without energy supplement. Steers that received energy supplement (wet corn gluten feed) gained 0.70 kg/d (FAST). Steers that did not receive energy supplement gained 0.19 kg/d (SLOW). Following the winter, yearling steers grazed summer pastures followed by finishing. Steers used for calf-finishing (CALF) were placed on feed in October and November. Feedlot initial weights were 423, 370, and 278 kg for FAST, SLOW, and CALF, respectively. Year x treatment interactions were found ( $P < 0.05$ ) for ADG, DMI, and feed efficiency. Steers on the FAST treatment gained faster ( $P < 0.05$ ) than SLOW, which gained faster ( $P < 0.05$ ) than CALF in 1995. In the remaining three yr, yearlings gained similarly, and more ( $P < 0.05$ ) than CALF. For DMI, FAST consumed more ( $P < 0.05$ ) than SLOW which consumed more ( $P < 0.05$ ) than CALF in 1995 and 1996. However, in 1997 and 1998, DMI was similar for yearling steers, and was increased ( $P < 0.05$ ) compared to CALF. Feed efficiency was improved ( $P < 0.05$ ) for CALF compared to FAST and SLOW in three yr. However, in 1997 efficiencies were similar. Steers on the FAST treatment profited \$21.00/head compared to losses for SLOW (-\$20.66/head) and CALF (-\$23.18/head) when the entire yearling systems were compared to calf-finishing. A comparison was also made of the economics of calf-finishing and yearling treatments only during finishing. Steers on the FAST treatment profited \$29.78/head compared to \$17.83/head

(SLOW) and \$-23.18/head (CALF). In this analysis, the FAST wintering system was superior to SLOW and CALF whether the entire yearling system or only the feeding period were evaluated. Several factors can interact with profitability such as purchase price, forage costs, corn price, and slaughter cattle price which will impact results.

**Key Words:** Yearling-finishing, Calf-finishing, Slaughter Breakeven

**95 Effect of group size on pig performance in a wean-to-finish production system.** B. F. Wolter\*<sup>1</sup>, M. Ellis<sup>1</sup>, S. E. Curtis<sup>1</sup>, N. R. Augspurger<sup>1</sup>, D. N. Hamilton<sup>1</sup>, E. N. Parr<sup>2</sup>, and D.M. Webel<sup>2</sup>, <sup>1</sup>University of Illinois at Urbana-Champaign, <sup>2</sup>United Feeds, Inc. Sheridan, IN 46069.

Crossbred pigs (n = 1,400) were used to evaluate the effect of group size (25 vs 50 vs 100 pigs/pen) in a wean-to-finish system on growth performance and carcass measures. Pigs were weaned at 17 d of age (5.9 ± 0.02 kg BW) and taken to a final mean pen weight of 116 ± 0.9 kg. A 10-phase dietary regimen was used, and pigs had free access to feed and water. Feeder-trough space (4.3 cm/pig) and floor-area allowance (0.68 m<sup>2</sup>/pig) were the same for all group sizes. Pigs in groups of 50 and 100 animals compared to 25 were lighter (P < 0.001) at the end of wk 8 after weaning, and had lower (3%, P < 0.01) average daily gain (ADG) and gain:feed (G/F), but similar (P > 0.10) average daily feed intake (ADFI) during the first 8 wk of the study. At the end of the study, pig weight (116 kg BW) and the coefficient of variation in pig weight within a pen were similar (P > 0.10) across group sizes. During the period from 8 wk after weaning to the end of the study, pigs in groups of 100 compared to 50 had greater (3%, P < 0.01) ADG, with pigs in groups of 25 being intermediate. Average daily feed intake during this period was similar (P > 0.10) for all group sizes, however, G/F was greater (3%, P < 0.01) for groups of 100 compared to 25 and 50 animals. For the overall study period, ADG, ADFI, and G/F from weaning to slaughter weight were similar across group sizes (P > 0.10; 655, 648, and 658 g; 1759, 1755, and 1759 g; and 0.37, 0.37, and 0.37; for ADG, ADFI, and G/F, respectively, for groups of 25, 50, and 100 pigs, respectively). Mortality was similar (P > 0.10) across group sizes; however, morbidity (pigs removed due to poor health or injury) was higher in groups of 25 pigs compared to the other two group sizes (7.0, 3.5, and 3.9 % for groups of 25, 50, and 100, respectively; P < 0.05). Group-size treatment did not affect (P > 0.10) carcass dressing percent, backfat thickness, or loin-eye depth. In summary, growth performance from weaning to market weight was not affected by group size.

**Key Words:** Pigs, Group size, Wean-to-finish

**96 The effect of an anabolic implant on allometric growth of steer calves.** K. W. Bruns\*, R. H. Pritchard, and B. J. Johnson, *South Dakota State University*.

Angus and Angus x Limousin steers (n=164) were used to evaluate the influence of an estradiol-trenbolone acetate implant (revalor - s) on production efficiency and carcass traits when administered at specific stages of growth. Treatments (TRT) were as follows: NI) control No Implant; EI) Early Implant, d 1, BW=309 kg; or DI) Delayed Implant, d 56, BW=385 kg. Steers were procured at weaning and were backgrounded (40d) prior to the initiation of the trial. Days on feed was constant across TRT. After 56 d, ADG and gain efficiency (G/F) were improved (P<.01) by implants, NI vs. EI (1.68 vs. 1.90 kg and .227 vs. .257). After 112 d, DI caused higher ADG than NI or EI (NI 1.65, EI 1.57, DI 1.78 kg; P<.05) and higher G/F (NI .155, EI .150, DI .173; P<.01). Cumulative ADG and G/F were improved by implants (1.65 vs. 1.73 kg; P<.05) and (.175 vs. .186; P<.01) for NI vs. I, respectively with no difference between implant TRT. Cumulative DMI was similar for TRT. Implants increased dressing percent (60.9 vs. 61.6 %; P<.05), increased (P<.01) carcass weight and REA (341 vs. 353 kg and 76.5 vs. 81.4 cm<sup>2</sup>) for NI vs. I, respectively. Backfat and KPH were unaffected by TRT. Implants advanced (P<.01) maturity scores (A<sup>51</sup> vs. A<sup>59</sup>) NI vs. I, respectively. Marbling scores were reduced (P<.05) by EI and were unaffected by DI (NI Small<sup>65</sup>, EI Small<sup>21</sup>, DI Small<sup>35</sup>). Treatment affected (P<.10) the proportion of carcasses with marbling scores greater than Modest<sup>0</sup> (NI 23.6, EI 7.8, DI 22.6 %). The results of this study suggest that delayed implanting can improve the percentage of carcasses grading average Choice and higher without adversely affecting production rates and efficiencies. The mechanism by which DI increased the proportion of carcasses grading Modest<sup>0</sup> or better may be due to an elevated caloric intake prior to the exposure of the anabolic

implant and/or because the implant was administered after the stage of growth when the rate of intramuscular fat deposition is greater than subcutaneous fat deposition.

**Key Words:** Beef, Implant, Marbling

**97 Effect of Tryptophan regimen on viremic state and growth of viral challenged pigs.** C. P. Machado\*, T. S. Stahly, and K. J. Yoon, *Iowa State University, Ames*.

To determine the effect of dietary tryptophan (Trp) on the viremic state and associated growth of animals during an acute viral challenge, pigs were self fed one of four dietary total Trp concentrations: .09, .135, .18 and .225% which represented 50, 75, 100 and 125% of the ideal ratio (IR) of Trp:Lys, respectively (NRC, 1998). Lysine was provided at 0.95% of the diet and all other amino acids were provided at a minimum of 100% of IR of Lys. Trp concentrations were achieved by substituting L-Trp for starch in the basal corn-soy-gelatin diet. Sixteen sets of four littermate barrows from a high lean strain and a PRRS naive herd were reared via an SEW scheme, penned individually and randomly allotted within litter to Trp diets at 26 d of age (9.1 ± 1.8 kg BW). Four days later (d 0), each pig was oral-nasally inoculated with 2 ml of 10<sup>4</sup> PRRS strain JA142/ml. Pigs were subsequently bled each 12 hr from d 1 through 9 post inoculation (PI) and on d 10, 12, 16, 20 PI. BW gain and feed intake for each 4-day period were measured from d -4 to 20 PI. Based on a two-slope breakpoint analysis, lowering dietary Trp from 125 to 50% of IR minimized (P<0.05) peak serum virus concentration from 10<sup>4.52</sup>, 10<sup>4.32</sup>, 10<sup>4.13</sup>, to 10<sup>3.84</sup> for pigs fed 125, 100, 75, and 50% Trp, respectively. The associated growth response of pigs to Trp regimen was dependent on the animal's viremic state. Lowering dietary Trp reduced daily gain and gain:feed ratio in each 4-day period but the degree of reduction was minimized in periods of acute viremia (d 0 to 8 PI), resulting in a diet by period interaction (P<0.01). Lowering Trp from 125 to 50% of IR reduced daily gains in each of the six consecutive 4-day periods from d -4 to 20 PI by 434, 259, 83, 330, 408, and 392 g, respectively. Based on this study, lowering dietary Trp during a viral challenge minimized viral replication. Therefore, it could be beneficial to reduce Trp intake at the initiation of an acute viremic state and then increase Trp intake when the viremic state is controlled.

**Key Words:** Pigs, Tryptophan, PRRS Virus

**98 Effect of exogenous infusion of LH on development of ovarian follicular cysts (cysts) in lactating dairy cattle.** J. H. Hampton\*<sup>1</sup>, B. E. Salfen<sup>1</sup>, J. F. Bader<sup>1</sup>, D. H. Keisler<sup>1</sup>, and H. A. Garverick<sup>1</sup>, <sup>1</sup>University of Missouri.

Two experiments were conducted to test the hypothesis that a high pulse frequency and amplitude delivery of exogenous LH would induce cysts in lactating dairy cows. In Exp. 1, estrus was synchronized in 12 lactating, cycling dairy cows and day of ovulation was determined by ultrasonography. Following emergence of the second follicular wave (d 0), cows received LH (40 mg/h; n = 7) or saline (CON; 2 mL/h; n = 5). Treatments began on d 1 and were delivered via a computer-controlled syringe pump. On d 2 all cows received two injections of PGF<sub>2α</sub>, 12 h apart. Treatments were administered for 5 (n = 5) or 7 (n = 7) d, or until ovulation. In Exp. 2, 13 lactating, anestrous dairy cows (mean = 8 d postpartum) received LH (40 mg/h; n = 6) or saline (CON; 1 mL/h; n = 7). Treatments were given as in Exp. 1 for 7 d, beginning 24 h after the emergence of the first follicular wave. In both experiments, blood samples were collected daily to determine serum concentrations of progesterone (P4), LH, and FSH. On d 3, blood samples were also collected at 12 min intervals for 8 h to determine LH profiles. During infusion, serum P4 and FSH were similar in LH-treated and CON cows (P > 0.05) in both experiments. Infusion of LH increased serum LH in a high pulse frequency and amplitude pattern in both experiments. However, the number of cows forming cysts did not differ between LH-treated and CON cows in Exp. 1 (1 of 7 vs 0 of 5, P = 0.58) or Exp. 2 (1 of 6 vs 0 of 7, P = 0.46). In cows that ovulated, mean d to ovulation from initiation of treatments did not differ (P = 0.10) in Exp. 1 (6.0 ± 0.15 vs 6.4 ± 0.16, in LH-treated vs CON cows, respectively), while in Exp. 2, mean d to ovulation was earlier (P ≤ 0.001) in LH-treated vs CON cows (5.6 ± 1.8 vs 19.9 ± 1.5, respectively). In summary, high



peripheral concentrations of LH alone are not a causative factor in development of cysts in lactating dairy cows. However, pulsatile infusion of LH decreases the interval to first ovulation in postpartum cows.

**Key Words:** LH, Cysts, Cows

**99 Effect of pregnancy and nutrient restriction on visceral mass and cellularity.** A. N. Scheaffer\*, D. R. Arnold, D. J. Smith, M. L. Bauer, L. P. Reynolds, and J. S. Caton, *North Dakota State University, Fargo.*

Twenty-eight mature cross-bred white-faced ewes ( $60 \pm 10$  kg initial BW) were fed a pelleted forage-based diet and used to evaluate effects of pregnancy and nutrient restriction on visceral organ mass and cellularity (hyperplasia and hypertrophy). Treatments were arranged in a 2 x 3 factorial, with dietary restriction (60%, R, vs 100% maintenance, M) and slaughter period (non-pregnant, NP, d-90, and d-130) as main effects. Visceral organ weights were collected from non-pregnant and pregnant ewes (n = 4, 5, and 5 for NP, d-90, and d-130 within each diet, respectively). Dietary treatments were initiated at d-50 of gestation

and remained at 60% of M throughout the experiment. Non-pregnant ewes were fed dietary treatments for 40 d. Fetal mass and Empty BW (EBW) were decreased due to R compared with M (2.30 and 47 vs 2.54 and 55 kg;  $P = 0.01$ , respectively). However, the main effect of R on EBW existed because of an affect at d-130 (51 vs 62 kg, respectively;  $P \leq 0.01$ ). Liver mass was reduced by R (14.4 vs 16.7 g/kg EBW;  $P \leq 0.01$ ), and increased from the NP to d-90 (14.1 vs 17.0) and then decreased to d-130 (15.8). Total visceral mass was not affected by treatment or slaughter period ( $P \geq 0.10$ ). Small intestine and mesenteric mass were also unaffected ( $P \geq 0.10$ ). Cellularity of the small intestine was not impacted by R ( $P \geq 0.10$ ). However, jejunal cell number (DNA mg/g of tissue) was greater ( $P \leq 0.01$ ) in R at d-130 compared with M; while ileal tissue tended ( $P = 0.11$ ) to have decreased number of cells in response to R. Cell size (protein:DNA) was similar between treatments ( $P \geq 0.10$ ). These data suggest liver mass decreases due to R. In this study, restriction of pregnant ewes did not impact cellularity of the small intestine or mass of the gut. Pregnant ewes were able to maintain gut mass and cellularity throughout the R period.

**Key Words:** Plane of Nutrition, Pregnancy, Intestinal Cellularity

## GROWTH, DEVELOPMENT, MUSCLE BIOLOGY, AND MEAT SCIENCE

**100 Identification of genes downstream of myostatin in the developing bovine embryo.** J.K. Potts\*<sup>1</sup>, T.P.L. Smith<sup>2</sup>, and J.M. Reecy<sup>1</sup>, <sup>1</sup>Iowa State University, Ames, IA, <sup>2</sup>USDA MARC, Clay Center, NE.

Recently, it was reported that mutations in myostatin, a TGF- $\beta$  family member, were responsible for the double muscling phenotype in cattle. However, the molecular mechanisms whereby myostatin inhibits skeletal muscle growth have not been elucidated to date. Therefore, the objective of this study was to identify genes that are differentially expressed in double-muscled (mh) and wild-type (wt) bovine embryos. To accomplish this, dams and sires, selected and bred to minimize genetic variation at loci other than myostatin, that were heterozygous for the Belgian Blue myostatin allele were mated to generate +/+, mh/+ and mh/mh bovine embryos. Previous research had demonstrated that myostatin was first expressed at day 29 of embryonic development. Therefore, dams were slaughtered after 31, 32, and 33 days of gestation in order to collect embryos approximately 2 to 4 days after the initiation of myostatin expression. Individual embryos were genotyped to determine the myostatin alleles present. For suppression subtractive hybridization analysis (SSH), total RNA was extracted from two wt and two homozygous mh embryos using the RNeasy mini kit. Subsequently, polyA RNA was purified from pooled total RNA samples with the Oligotex RNA mini kit. Subtraction of embryonic cDNA was performed with the PCR-Select cDNA Subtraction Kit. Differentially-expressed cDNAs were amplified by two suppression PCR amplifications with the Advantage cDNA PCR Kit. Subtracted PCR products were ligated into the T/A cloning plasmid vector pT-Adv and sequenced to determine their identity. Of the first 58 expressed sequence tags (EST), 72% of the EST were homologous to known bovine EST. Whereas, 18% of the EST were novel. In addition, 24% of these 58 EST had no homology to any known gene in any other species. These results provide new information concerning changes in gene expression associated with the double-muscled phenotype in cattle and indicate that SSH is an efficient method for identifying differentially expressed genes in cattle.

**Key Words:** Myostatin, Expressed Sequence Tag, Cattle

**101 Altered myosin heavy chain isoform transitions in satellite cells and pectoralis major muscle from LSN chickens.** A. Yilmaz\*, M. Wick, and S.G. Velleman, *The Ohio State University, Columbus, OH.*

The aim of this study was to determine the temporal expression of sarcomeric myosin heavy chain (MyHC) isoforms in proliferating and differentiating satellite cells as well as in the pectoralis major (PM) muscle derived from Low Score Normal (LSN) chickens. Myosin was isolated from LSN and normal satellite cell tissue culture or the PM and analyzed by semi-quantitative enzyme-linked immunosorbant assay (ELISA) using monoclonal antibodies specific for ventricular (HV11), neonatal (2E9) and adult (AB8) myosin heavy chain isoforms. ELISA results of MyHC isoforms derived from LSN satellite cells showed delayed expression of the ventricular myosin isoform in proliferating as well as differentiating

cells for up to 48 hrs. In contrast, neonatal and adult isoforms were expressed in significantly higher concentrations in proliferating and differentiating LSN satellite cells at nearly all times assayed. These results suggest that the mechanisms down-regulating ventricular MyHC expression in LSN animals may participate in the simultaneous and sustained increase in the expression of more mature MyHC isoforms, *in vitro*. Temporal MyHC isoform transitions in the embryonic PM of LSN birds showed earlier onset of the ventricular MyHC isoform than control embryos of the same age. In addition, delayed expression of neonatal and adult MyHC isoforms was observed in post hatch and adult LSN chickens compared to control birds of the same ages. The altered MyHC isoform expression observed in the PM of LSN chickens may be associated with the changes in myotube and sarcomere morphology and the observed delay in muscle development in LSN chickens.

**Key Words:** Myosin Heavy Chain, Low Score Normal, Satellite Cells

**102 Changes in muscle ultrastructure and temporal expression of myosin heavy chain isoforms in selenium deficient chickens.** A. Yilmaz\*, M. Wick, and J.D. Latshaw, *The Ohio State University, Columbus, OH.*

The objectives of this study were to determine the temporal changes in muscle ultrastructure and myosin isoform expression in chickens recovering from selenium (Se) deficiency by employing electron microscopy (EM) and enzyme linked immunosorbant assay (ELISA) with monoclonal antibodies (mAbs) specific for cardiac ventricular (HV11) and chicken fast sarcomeric neonatal (2E9) myosin heavy chain isoforms. Hens were fed a low Se diet to reduce Se carryover to chicks. Chicks were then fed a Se-deficient diet (0.04 ppm Se) or control diet (0.10 ppm added Se). Those birds fed the Se-deficient diet began to develop exudative diathesis (ED) at about 14d. Individual chicks showed evidence of ED from 14d to 28d, and each was injected subcutaneously with 15  $\mu$ g of selenite Se. Chicks were euthanized at 28d post-hatch and represented birds from 0d to 10d post-Se injection. The pectoralis major (PM) was removed and either immediately embedded for EM or stored on ice prior to myosin extraction for analysis by ELISA. Electron micrographs of the muscles from Se-deficient animals demonstrated shrunken mitochondria, and a generalized disruption of the sarcomere architecture with a pronounced loss of M-line structure. These changes in myofiber architecture may account for the loss of muscle function observed in Se deficient chickens. Both M-line and mitochondrial structures were gradually re-established by 10d post-injection. ELISA results demonstrated little or no expression of ventricular MyHC isoform, which is generally considered to be a participant in muscle regeneration. Expression of the neonatal MyHC isoform was expressed at times consistent with the expression observed in regenerating cold injured muscles. These results suggest that muscles recovering from Se-induced myopathy skip a step in the recapitulation of MyHC isoform ontogeny normally associated with muscle regeneration and may partially account for the rapid recovery rates observed in Se deficient birds upon administration of selenite.

**Key Words:** Myosin Heavy Chain, Selenium Deficiency, ELISA

**103 Protein accretion in pigs infected with *Mycoplasma hyopneumoniae*.** J. Escobar\*<sup>1</sup>, W.G. Van Alstine<sup>2</sup>, D.H. Baker<sup>1</sup>, and R.W. Johnson<sup>1</sup>, <sup>1</sup>University of Illinois, Urbana, IL, <sup>2</sup>Purdue University, W. Lafayette, IN.

*Mycoplasma hyopneumoniae* (Mh) is a cause of enzootic pneumonia. Although Mh is thought to impair growth, protein accretion (PA) in pigs with pneumonia has not been reported and how Mh reduces growth is unknown. The objectives of this study were to evaluate the effects of Mh on PA in nursery pigs and determine if a change in PA was associated with increased expression of interleukin (IL)-1 $\beta$ , IL-6 and tumor necrosis factor (TNF)- $\alpha$ . Sixty-four 2-wk-old Mh-free pigs were used (two trials) in a completely randomized block design. In each trial, two pigs were housed in each of 16 chambers. At 4-wk of age pigs were inoculated with 3 ml Friis or Mh (P5722-3, 10<sup>7</sup> cfu/ml). Clinical signs of disease and FI were monitored daily and BW was determined weekly for 4 wk. Whole-body composition was determined from pigs killed 0, 14 and 28 d postinoculation (pi). At sacrifice, lung lesions were quantified and lung tissue was collected to verify the presence or absence of Mh and to determine cytokine mRNA levels. On the one hand, control pigs presented no overt signs of infection, were Mh negative and free of pulmonary lesions. On the other hand, Mh pigs showed pneumonic coughing, were Mh positive, and had pulmonary lesions that affected 4.5% ( $P < 0.01$ ) and 14.1% ( $P < 0.001$ ) of total lung area at 14 and 28 d pi, respectively. Ribonuclease Protection assays showed increased IL-1 $\beta$  ( $P < 0.04$ ) and TNF- $\alpha$  ( $P < 0.06$ ) mRNA in tissue from the lesioned site compared to tissue collected 10 cm from lesioned site or from control pigs. Surprisingly, Mh did not depress BW, ADG, ADFI, or G:F during any week. Moreover, Mh did not affect water, fat, CP or ash accretion. Despite induction of chronic disease and local expression of cytokines, these data indicate that Mh alone was insufficient to affect growth performance in nursery pigs. The ability of pigs to contend against Mh may have been due to the absence of other pathogens that are often isolated from pigs with enzootic pneumonia.

**Key Words:** Cytokines, Growth performance pig, Mycoplasma

**104 Effects of summer heat on growth, carcass composition, and quality grades in feedlot steers.** M.J. Leonard\*, E.P. Berg, D.E. Spiers, and L.E. McVicker, University of Missouri, Columbia, MO.

Each summer there are economic losses in the Midwest due to heat-related reductions in steer performance. A 120-day study was conducted during the summer of 2000 to determine the effects of heat stress on growth and carcass characteristics of feedlot cattle, and to evaluate the benefits of shade. Angus x Simmental steers (n=30: Avg initial BW 428 kg) were randomly divided into two groups of fifteen and maintained in either shaded or non-shaded feedlot pens. Steers were provided a typical finishing diet (NEg .65 Mcal/lb) and water ad libitum. Thermal status was measured using telemetric, temperature transmitters (CowTemp, Model BV-010) inserted into the rumen that continuously monitored core body temperature, and environmental conditions (air temperature and percent relative humidity) were recorded using data loggers (Onset Hobo). Maximum/minimum values for air temperature and temperature-humidity index were 34.7/13.5 °C and 86/56, respectively. Steers were harvested in groups of 10 with 5 animals coming from each treatment group. Carcass yield and quality grades, muscle pH, Hunter L\*, a\*, and b\*-values, color saturation, and hue were determined 48 hours postmortem. The most significant effect was on muscle composition, with ribeye area (13.0 vs. 11.9 in.<sup>2</sup>,  $P < 0.04$ ) and hot carcass weight (355.4 vs. 335.5 kg,  $P < 0.04$ ) being increased in shaded animals. However, there were no significant differences between quality and yield grades, due to similarities in back fat, KPH fat, and marbling scores. While there was some indication that shade improved carcass muscling during heat stress, the benefit of shade was not completely realized due to the mild summer conditions. Further studies will evaluate additional benefits of shade on carcass composition and quality during more severe periods of heat challenge.

**Key Words:** Carcass quality, Heat stress, Beef cattle

**105 Appetite-regulating gene expression is altered by weaning in 2-wk-old pigs.** R.L. Matteri\*<sup>1</sup>, A. Woldegebriel<sup>2</sup>, C.J. Dyer<sup>3</sup>, D.H. Keisler<sup>4</sup>, D.L. Grohs<sup>3</sup>, and F.C. Buonomo<sup>3</sup>, <sup>1</sup>Animal Physiology Research Unit, USDA-ARS, Columbia, MO, <sup>2</sup>Lincoln University, Jefferson City, MO, <sup>3</sup>Monsanto Co., Chesterfield, MO, <sup>4</sup>University of Missouri, Columbia, MO.

Weaning the piglet results in a well-characterized reduction in nutritional intake and growth. The objective of this study was to evaluate changes in hormonal indicators of nutritional status and the expression of genes involved in appetite control 24 h after weaning. At 14 d of age, piglets were either weaned (W) or kept with their sow (S). Each treatment group consisted of 6 barrows and 6 gilts. Animals were sacrificed after 24 h for blood and tissue collection. Weight gain over this period was significantly affected by weaning (.36  $\pm$  .03 and -.26  $\pm$  .03 kg in S and W pigs, respectively;  $P < .0001$ ). Serum growth hormone concentrations were higher in W, compared to S piglets ( $P < .0001$ ). Conversely insulin-like growth factor (IGF)-1 and IGF-2 concentrations were reduced by weaning ( $P < .0001$ ). The only significant difference between sexes was observed in serum IGF-2 concentrations, which were highest in barrows ( $P < .01$ ). Serum insulin levels did not differ between groups. Weaning increased agouti-related protein (AGRP) mRNA levels by 25% in the hypothalamus ( $P = .019$ ), and tended to increase neuropeptide-Y (NPY;  $P = .08$ ) and melanin-concentrating hormone (MCH;  $P = .09$ ) mRNA. Weaning did not affect hypothalamic mRNA levels of cocaine and amphetamine-regulated transcript, MCH receptor, type 4 melanocortin receptor, type 2 orexin receptor, or orexin. The results suggest that increased production of hypothalamic AGRP, an appetite-stimulatory factor, may be involved in the recovery of intake and growth following weaning.

**Key Words:** Pig, Weaning, Appetite

**106 Growth and body composition in growing-finishing pigs fed a liquid milk replacer diet throughout the nursery phase.** M. E. Spurlock\*<sup>1</sup>, J. L. Kuske<sup>1</sup>, C. Camacho-Rea<sup>1</sup>, G. R. Frank<sup>2</sup>, G. M. Willis<sup>2</sup>, and K. L. Houseknecht<sup>3</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, <sup>2</sup>Purina Mills, Inc., St. Louis, MO, <sup>3</sup>Pfizer, Inc., Groton, CT.

At weaning, 96 pigs were placed in 12 replicate pens per diet (4 pigs per pen), and fed a liquid milk replacer (MR) or conventional dry diet regimen (DD) throughout the 5-week nursery phase. At the end of 5 wk, 12 pigs from each diet (1 pig per pen) were killed for determination of whole body chemical composition. The remaining pigs were assigned to BW groups (60, 85, and 110 kg), placed in individual pens, and fed a commercial-type growing-finishing regimen until killed at their respective BW targets for determination of the chemical composition of whole empty bodies. Over the nursery phase, the ADG of the pigs fed the MR exceeded that of the pigs fed the DD by 44% ( $P < 0.05$ ). Fat gain in these pigs was 1.8 times that of the pigs fed the DD, and percentage body fat was 45% greater ( $P < 0.05$ ). Acetyl-CoA carboxylase activity (per mg of adipose extract protein) was not different between the two diet groups at the conclusion of the nursery period. By 110 kg BW, body fat was actually reduced ( $P < 0.05$ ) by 7.7% (actual fat mass) and 8.3% (percentage basis) the pigs fed MR vs. the DD group. In the nursery phase, actual protein gain was increased ( $P < .05$ ) 22% by feeding the MR. Whereas leptin mRNA abundance increased ( $P < 0.05$ ) in adipose tissue with BW, there was no effect of diet. The abundance of the mRNA for peroxisome proliferator activated receptor (PPAR) gamma 1 or 2 was not influenced by diet or BW. However, the abundance of the mRNA for PPAR alpha at 85 kg BW was 1.6 times ( $P < 0.05$ ) that of the pigs sampled at the completion of the nursery phase. These data provide additional evidence that pigs have considerably more potential for growth in the nursery phase than we typically achieve with conventional weaning programs. Furthermore, body fat in these pigs seemed to adhere to a set point principle such that compensatory changes in fat gain corrected the early diet-induced obesity.

**Key Words:** pig body composition, pig growth, leptin

**107 Ractopamine, beta-agonists and muscle research: where do we go from here?** Don H. Beermann\*, *University of Nebraska, Department of Animal Science.*

Mechanisms by which Ractopamine and other beta-adrenergic agonists stimulate skeletal muscle growth will be discussed. Receptor specificity differences preclude generalizations regarding mechanisms of action. Oral administration dose-response studies in laboratory animals provide evidence that indirect endocrine-mediated effects are not an essential component of efficacy. Results from age-comparison studies in laboratory animals and livestock species provide evidence that metabolic maturity of skeletal muscle may be a critical factor with regard to efficacy, suggesting that receptor presence and density is important. Temporal studies demonstrate the rapidity of responses associated with protein and lipid metabolism changes, and the progressive decline in rate of anabolic response in skeletal muscle. Investigations in which progressive beta-adrenergic receptor density reductions are observed suggest, likewise, that protein accretion rate and muscle growth rate responses are receptor-mediated. Measurement of direct in vivo metabolic effects have been conducted in relatively few experiments. Detailed blood flow and hind limb net flux data are available for a single beta<sub>2</sub>agonist, cimaterol. Pharmacokinetics and net flux studies using close arterial infusion of cimaterol in the hind limb of growing cattle demonstrate large transient increases in essential amino acid extraction from the circulation and net uptake when compared to the control saline-infused contralateral hind limb. Predictions of differential net effects on protein accretion using integration of essential amino acid accretion measurements during 21 days of treatment is corroborated by quantitative differences in protein mass of individual muscles from treated and control hind limbs. Definitive signal transduction pathway mechanism(s) of action for changes in protein synthesis and degradation have not been reported. Therefore, elucidation of cellular and intracellular components of the mechanism(s) associated with beta-agonist induced skeletal muscle hypertrophy is incomplete.

**Key Words:** Ractopamine, Beta Agonists, Muscle Growth

**108 Beta-adrenergic receptor modulation of adipocyte metabolism and growth.** Harry J. Mersmann\*, *USDA/ARS Children's Nutrition Research Center, Department of Pediatrics, Baylor College of Medicine.*

Beta-adrenergic receptor (BAR) agonists reduce body fat in mammals and birds. Synthetic adipocyte lipid metabolism is decreased in BAR agonist-treated animals or by agonists in adipocytes in vitro. Degradative lipid metabolism is increased by BAR agonists in adipocytes in vitro and in vivo. The BAR agonist effects are blocked by BAR antagonists. In mammalian tissues, there are at least three distinct beta-adrenergic receptor (BAR) subtypes; beta-1 (B1AR), beta-2 (B2AR), and beta-3 (B3AR). Individual tissues have different proportions of subtypes, e.g., greater than 85% of the BAR in rat heart = B1AR, in hamster lung = B2AR, and in rat adipocytes = B3AR. Subtype distribution within a tissue varies with species, e.g., human heart has 65% B1AR and porcine adipocytes have less than 10% B3AR. Also, there is species variation in the amino acid sequence of a subtype. Thus, it is expected that some BAR agonists would have different effects in the same tissue in different species because of different BAR subtype distribution and/or amino acid sequence. In support of these concepts, the pharmacology of BAR agonists and antagonists in adipocytes is in many cases species specific. Cloning of individual BAR subtypes allows determination of the pharmacology of subtypes from that species, e.g., porcine B1AR, B2AR, and B3AR were cloned by Mills and co-workers (Purdue). Cloned subtype pharmacology indicates selected agonists or antagonists can be used to assess the proportion of BAR subtypes. Nucleic acid sequences of the subtypes were used to prepare probes to quantify the subtype mRNAs. The pharmacological and mRNA data agree rather closely and indicate porcine adipocytes contain 70+ percent B1AR. The effects produced by a BAR agonist (or antagonist) on adipose tissue in vivo depend not only on the species and the adipocyte BAR subtype distribution, but also on the pharmacokinetics and pharmacodynamics of the compound in that species, including blood flow to the tissue, and the multiple metabolic and endocrine effects of the compound in other tissues of the body. In short, it is expected that individual BAR agonists would have somewhat different effects in different species.

**Key Words:** Adipocyte, Beta-adrenergic receptor subtypes, Beta-adrenergic receptors

**109 Implications of feedback regulation of Beta-adrenergic signaling.** S.E. Mills\*, *Purdue University, West Lafayette, IN.*

Receptor-mediated signals are tightly regulated by feedback inhibition and act to prevent signal overload and to reset the receptor to a changing environment. Short-term regulation (desensitization) of beta-adrenergic receptors ( $\beta$ AR) involves receptor phosphorylation and uncoupling of the receptor from the G protein Gs. Chronic exposure to ligand leads to reduced receptor number (down regulation), and results from a combination of receptor internalization and degradation, and decreased mRNA abundance. The extent of  $\beta$ AR regulation is subtype-specific with a rank order of  $\beta$ 2AR >  $\beta$ 1AR >  $\beta$ 3AR. Differences between species are expected also because amino acid sequence differs. Desensitization and down-regulation of  $\beta$ AR in pig tissues has been demonstrated in vivo and in vitro, although skeletal muscle exhibits a blunted response compared to adipose tissue and changes in mRNA abundance have not been observed. Desensitization presents a challenge clinically in the treatment of human disease and may well limit the effectiveness  $\beta$ AR ligands used to promote livestock production. Pigs fed  $\beta$ AR ligands show a rapid response in growth and feed efficiency that tends to peak during the first 7 to 10 days but declines thereafter toward zero by approximately six weeks. A similar pattern was reported in rats fed clenbuterol and was accompanied by a 50 percent reduction in  $\beta$ AR in skeletal muscle. Feeding clenbuterol every second day prevented the decline in the response to clenbuterol and gave a growth response that was equivalent to daily dosing. These data suggest that strategies to prevent or circumvent  $\beta$ AR down regulation may prolong the agonist response. Intermittent dosing of pigs may present logistical problems. An alternative approach may be to incrementally increase the dose of  $\beta$ AR ligand to compensate for the decline in response or to augment the ligand response by inhibiting the inhibitory G protein Gi.

**Key Words:** Pig, Adrenergic Receptor, desensitization

**110 Potential issues in meat quality of animals fed  $\beta$ -adrenergic agonists: A review.** M. Koochmariaie\*, S. D. Shackelford, and T. L. Wheeler, *USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

The objective of this presentation is to review the effect as well as the mode of action of dietary administration of  $\beta$ -Adrenergic Agonists (BAA) on meat quality in general and specifically meat tenderness. The biological basis of meat tenderness is not species dependent. The combination of sarcomere length, connective tissue content and state, and proteolysis of myofibrils and associated proteins will explain the great majority of the variation in tenderness of various muscles. The relative contribution of these factors is muscle dependent. We have shown that longissimus dorsi (LD) has intermediate shear force value at slaughter (probably tender). However, there is a dramatic rise in LD shear force during rigor development. Sarcomere shortening that accompanies rigor development is the cause of rise in shear force value. We have called this period the toughening phase and believe that it occurs equally in LD of all carcasses. At some point after slaughter (it has not been documented conclusively, but perhaps about 3 h postmortem), an opposite process, proteolysis, will begin. We call this process the tenderization phase. It is well established that there is much variation in the rate and extent of tenderization between muscles and species. We believe the variation in tenderization is responsible for variation in meat tenderness, and that  $\mu$ -calpain-mediated proteolysis of key myofibrils and associated proteins is the cause of LD tenderization. In general, feeding BAA has been shown to have a positive effect on growth performance and carcass composition and, with the exception of a reduction in meat tenderness, no effect on meat quality traits. When it occurs, the detrimental effect of BAA on meat tenderness results mostly from reduced calpain proteolysis due to elevated calpastatin activity. The extent of decreased meat tenderness appears to be agonist specific, dose and species dependent.

**Key Words:**  $\beta$ -agonists, tenderness, calpastatin

**111 The effect of Paylean® on the growth performance of finishing swine fed under commercial conditions, summary of five trials.** W. C. Weldon\*, G. A. Armbruster, T. A. Marsteller, L. E. Watkins, R. D. Muller, and J. R. Wagner, *Elanco Animal Health, Greenfield, IN.*

Five trials were conducted to evaluate the effects of Paylean® (ractopamine-HCl) on the growth performance of finishing swine fed under commercial conditions. These trials involved 5016 pigs in 220 pens. Pens were assigned to one of three treatments. Control pigs (n = 71 pens) received no feed additives during the trial, and the remaining pigs received diets that contained either 10 (n = 75 pens) or 20 ppm (n = 74 pens) Paylean. Treatments were applied at an average weight of 77.2 ± .54 kg so that pigs would weigh approximately 109.1 kg, on average, at the end of the 42-d trial. Pigs were weighed and feed disappearance was determined on d 0, 14, 28, and 42 of treatment. Data were analyzed using analysis of variance. Feeding Paylean resulted in increased ADG, improved feed efficiency (F:G) and reduced ADFI. The ADG and F:G was improved during the first 28 d of Paylean feeding, but was not different during d 28 to 42. There was a significant trial by treatment interaction for ADG and F:G during the 29 to 42 of feeding. The ADFI was not different during d 1 to 14, but was reduced during d 15 to 28 and 29 to 42 of Paylean treatment. Feeding Paylean improved the growth performance and feed efficiency of finishing pigs fed under commercial conditions. Results are in the following table.

Paylean®, ppm	ADFI, kg	ADG, kg	F:G	Gain, kg
<b>D 1 to 14</b>				
0	2.43	0.891	2.75	12.59
10	2.41	0.995**	2.45**	14.03**
20	2.44	1.014**	2.43**	14.28**
SEM	0.01	0.012	0.03	0.17
<b>D 15 to 28</b>				
0	2.60	0.836	3.19	11.64
10	2.50**	0.838*	3.11*	11.77*
20	2.49**	0.877*+	2.89*+	12.33*+
SEM	0.030	0.010	0.03	0.16
<b>D 29 to 42</b>				
0	2.64	0.718	3.75	9.65
10	2.48**	0.686	3.76	9.21
20	2.42**	0.695	3.68	9.44
SEM	0.023	0.012	0.10	0.17
<b>D 1 to 42</b>				
0	2.51	0.818	3.13	33.88
10	2.46**	0.845**	2.93**	35.01**
20	2.45**	0.868**	2.83**	36.05**
SEM	0.023	0.007	0.02	0.29

Paylean effect, \*P < 0.05, \*\*P < 0.01; Paylean dose, 9 vs. 18, + P < 0.05

**Key Words:** Swine, Ractopamine, Growth

**112 Development of models to describe the weekly response of ractopamine.** A. P. Schinckel\*<sup>1</sup>, M. E. Einstein<sup>1</sup>, C. T. Herr<sup>1</sup>, Y. Wang<sup>1</sup>, K. A. Bowers<sup>1</sup>, S. L. Hankins<sup>1</sup>, T. E. Weber<sup>1</sup>, and B. T. Richtert<sup>1</sup>, <sup>1</sup>*Purdue University.*

One-hundred sixty pigs, 80 barrows and 80 gilts (BW = 71.9 kg) were allotted by sex and weight to evaluate the effect of phase feeding treatment (trt) of varying ractopamine (RAC) levels on growth performance and carcass traits. Pigs were fed one of four dietary trts ad libitum for 42 days: 1) Control diet containing no RAC; 2) Step-down RAC sequence: 20 ppm RAC wk 1 and 2; 10 ppm RAC wk 3 and 4; and 5 ppm RAC wk 5 and 6; 3) Step-up RAC sequence: 5 ppm RAC wk 1 and 2; 10 ppm RAC wk 3 and 4; and 20 ppm RAC wk 5 and 6; 4) Constant RAC, 11.6 ppm. A 19.6% crude protein (CP) diet, 1.2% lys, and an 18.5% CP diet with a 1.1% lys level was fed to gilt and barrow, respectively. Pigs were weighed weekly and feed consumption recorded to determine average daily gain (ADG), average daily feed intake (ADFI), and gain:feed (G:F). The RAC response was estimated as the performance of each pen fed RAC minus the week × sex mean for the control pigs. Statistical models were evaluated to predict the weekly RAC response for ADFI, ADG, and G:F for the three ractopamine treatments. Regression models

included independent variables from three sets of variables (1) variables involving functions of the RAC level (ppm) for that specific week; (2) the current RAC level minus the level fed one, two, or three wks prior; and (3) variables to describe the duration of RAC feeding such as cumulative weight gain, RAC intake (g), days on RAC, and cumulative products of weekly weight gain (kg), time, and RAC level (ppm). The majority of equations included current RAC level to the .5 power, a variable describing the current RAC level minus the RAC level fed two or three wks prior and a cumulative RAC duration variable. The best equations accounted for 82.9, 81.9, and 94.5% of the RAC treatment × week variation in RAC response for ADG, ADFI, and G:F respectively. The models were designed to simulate a pharmacological dose response to ractopamine. The results indicate that all three sets of variables should be included into RAC response models.

**Key Words:** Pigs, Ractopamine, Model

**113 The intermediate filament protein desmin is ADP-ribosylated in skeletal muscle cells.** W. Tong\*<sup>1</sup>, D. Burke<sup>2</sup>, R. Robson<sup>1</sup>, and T. Huiatt<sup>1</sup>, <sup>1</sup>*Iowa State University,* <sup>2</sup>*Indiana University.*

Mono-ADP-ribosylation is a protein modification involving transfer of ADP-ribose from NAD to an amino acid residue of a protein, catalyzed by mono-ADP-ribosyltransferase (ART). In previous studies we showed that an inhibitor of arginine-specific ART blocks terminal differentiation of embryonic chick skeletal myoblasts in cell culture, suggesting a role for this reaction in muscle differentiation. We have also shown that the muscle intermediate filament (IF) protein desmin is a substrate for purified arginine-specific ART, and that ADP-ribosylation blocks assembly of desmin into IFs in vitro. To determine if desmin is modified in developing skeletal muscle cells, we developed a method for detection of ADP-ribosylated proteins using RNA aptamers that bind to ADP-ribose as probes. Aptamers are small RNA molecules selected to bind to a target molecule by SELEX (Systematic Evolution of Ligands by EXponential enrichment). To test the method, desmin and glycogen phosphorylase were ADP-ribosylated using expressed ART. Both modified proteins and unmodified control proteins were spotted on blot media. Blots were overlaid with a radiolabeled RNA aptamer selected for binding to Coenzyme A, which contains an ADP-ribose moiety, and binding detected by autoradiography. The aptamer bound only to the ADP-ribosylated proteins, and binding was abolished by treatment with hydroxylamine, which removes ADP-ribose from arginine residues. This method was then used to examine desmin extracted from 5-d myotube cultures of embryonic chick myogenic cells. Soluble, unassembled desmin was extracted from the cells with a high-salt buffer and purified by immunoprecipitation with desmin antibody. This soluble desmin bound the aptamer on dot blots, and binding was abolished with hydroxylamine. Insoluble, filamentous desmin, purified by urea extraction and immunoprecipitation, did not react with the aptamer. These results provide a new method for detection of ADP-ribosylated proteins, demonstrate that desmin is ADP-ribosylated in muscle cells and suggest that ADP-ribosylation is involved in regulating desmin assembly. (Supported by USDA-NRICGP 00-35206-9381)

**Key Words:** ADP-ribosylation, Desmin, Intermediate Filaments

**114 Use of the yeast two-hybrid system to elucidate the multiple protein interaction domains within the muscle cell intermediate filament protein synemin.** R. Bellin\*, T. Huiatt, and R. Robson, *Iowa State University.*

The yeast two-hybrid system is a powerful technique for assaying specific protein interactions within the context of a living cell. This system takes advantage of the two-domain structure of the Gal4 yeast transcription factor, which has been shown to activate gene transcription when the two domains are brought spatially proximal to each other. By expressing the two separate Gal4 domains as protein fusions, each with one of a pair of potentially interacting proteins, it is possible to assay for the interaction of the protein pair based on the level of Gal4 activation of a reporter gene. In this study, we have used the two-hybrid system to probe the molecular interactions of synemin. Synemin is a very large (183 kDa) member of the intermediate filament (IF) protein superfamily that is present primarily in muscle cells. In previous studies we have shown by in vitro assays that synemin can interact with members of the IF superfamily and with alpha-actinin and vinculin. By use of the two-hybrid system we have further defined the specific interaction domains

of synemin within a living cell. We show that the rod domain of synemin is the major interaction site with the IF proteins desmin and vimentin, and that the last 300 amino acids of the large C-terminal tail domain of synemin contains binding sites for alpha-actinin and vinculin. These findings support our hypothesis that synemin functions as an important crosslinker between IFs and other cytoskeletal structures. Synemin appears to interact with other IF proteins to form heteropolymeric IFs, and in turn links those IFs to cellular structures containing alpha-actinin and/or vinculin. These interactions would permit the heteropolymeric IFs in muscle cells to both link together the Z-lines of neighboring myofibrils and to link the Z-lines of the outermost layer of myofibrils to costameric sites along the sarcolemma. These linkages would provide the structural ties needed for overall cytoskeletal integrity, and thereby promote efficient growth and development of muscle cells. (Supported by USDA-NRRC 99-35206-8676)

**Key Words:** Muscle Cell Cytoskeleton, Intermediate Filaments

**115 Differences in serum leptin concentrations across swine genetic lines.** K.R. Maddock<sup>\*1</sup>, D.H. Keisler<sup>1</sup>, R.N. Goodwin<sup>2</sup>, T.J. Baas<sup>3</sup>, D.W. Newcom<sup>3</sup>, and E.P. Berg<sup>1</sup>, <sup>1</sup>University of Missouri-Columbia, <sup>2</sup>National Pork Producers Council, Des Moines, IA, <sup>3</sup>Iowa State University-Ames.

The objective of this study was to determine if serum levels of the hormone leptin differ between six genetic lines of swine representing various levels of growth potential, percentage carcass lean, degree of external fat, intramuscular fat (IMF), and meat quality. Weights and serum samples (L1) were collected from six different breeds of pigs entered in the National Barrow Show Sire Progeny Test. Breeds evaluated were Berkshire (B; n=132), Chester White (CW; n=37), Duroc (D; n=39), Landrace (L; n=26), Poland China (PC; n=26), and Yorkshire (Y; n=41). Serum samples were collected at 34 kg (L1) and again at 111 kg live weight (L2), approximately twenty-four hours prior to harvest. Measurements taken included hot carcass weight, carcass length, back fat, loin muscle area (LMA), percent yield, loin pH, Hunter L-value, chemically determined IMF, and subjective color, marbling, and firmness scores. Average daily gain, IMF percentages, and water-holding capacity (WHC) were calculated. Serum leptin levels (ng/ml) were determined using a heterologous leptin radioimmunoassay. Serum concentrations of leptin did not differ with respect to breed at L1 ( $P>0.1$ ) but differed significantly with breed at L2 ( $P<0.001$ ). Berkshire had the highest leptin levels ( $6.89\pm 0.35$ ) and Yorkshire had the lowest leptin levels ( $3.81\pm 0.62$ ). Serum concentrations of leptin at L2 were significantly correlated with ADG ( $P<0.001$ ), carcass length ( $P<0.001$ ), back fat ( $P<0.001$ ), LMA ( $P<0.001$ ), loin pH ( $P<0.05$ ), WHC ( $P<0.01$ ) and subjective marbling scores ( $P<0.02$ ), but not IMF ( $P>0.1$ ). Serum concentrations of leptin at L2 differed with gender with barrows having greater leptin than gilts ( $6.67\pm 0.36$  vs.  $3.84\pm 0.36$ ;  $P<0.001$ ). In conclusion, these data provide evidence that significant differences exist between genetic lines of pigs and serum concentration of leptin in a manner consistent for breed specific traits of growth, leanness, and quality. Further research must be conducted to determine if use of leptin as a marker for genetic specific traits is valid.

**Key Words:** leptin, swine, pork quality

**116 Interrelationships among carcass characteristics of feedlot steers and heifers selected for competition.** D. A. King<sup>\*1</sup>, T. E. Lawrence<sup>1</sup>, M. E. Dikeman<sup>1</sup>, and D. E. Schafer<sup>1</sup>, <sup>1</sup>Kansas State University.

The objective of our study was to evaluate the interrelationships among carcass characteristics of steers and heifers that had been selected from commercial feedlots for competition. Dressing percentage and USDA Quality and Yield grade data were obtained from steers (n=532) and heifers (n=414) entered in the 1994, 1995, 1999, and 2000 Beef Empire Days live and carcass contests. Other years were excluded due to incomplete data. Because criteria used in the Beef Empire Days contest is weighted heavily on cutability, cattle selected are trim and heavily muscled. Percentage kidney, pelvic, and heart fat (KPH), longissimus muscle area (LMA), longissimus muscle area per 100 kg of carcass weight (LMA/HCW), and adjusted fat thickness (FT) were stratified by dressing percentage (DP). Also, percentage of low Choice or higher, LMA, KPH, and hot carcass weight (HCW) were stratified by FT. Longissimus muscle area was stratified by HCW. Mean FT, LMA, and yield

grade were  $10.9 \pm 4.2$  mm,  $94.14 \pm 10.3$  cm<sup>2</sup>, and  $2.11 \pm 0.79$ , respectively. Heifers had higher ( $P<.05$ ) FT, LMA, LMA/HCW, KPH, and DP than steers. Steers had heavier ( $P<.05$ ) live weights and HCW than heifers. As DP increased, LMA increased ( $P<.05$ ) linearly and KPH increased ( $P<.05$ ) in a quadratic manner. Longissimus muscle area per 100kg of HCW did not differ across DP categories in steers; however, LMA/HCW did increase ( $P<.05$ ) with DP in heifers. Adjusted fat thickness did not change with DP, whereas KPH increased ( $P<.05$ ) and LMA decreased ( $P<.05$ ) with increasing FT. Interestingly, as DP increased the percentage of low Choice or higher carcasses tended to decrease. Steers had higher ( $P<.05$ ) HCW than heifers at all FT categories. As FT increased up to 17mm, the percentage of low Choice or higher carcasses increased. Increased HCW was related to increased ( $P<.05$ ) LMA, whereas increased FT was related to decreased LMA. These data on selected feedlot cattle indicate LMA has a greater impact on other carcass characteristics than previously identified.

**Key Words:** Beef, Carcass characteristics, Longissimus muscle area

**117 Temperature variation of cooking methods used for research.** T. E. Lawrence<sup>\*1</sup>, D. A. King<sup>1</sup>, and M. E. Dikeman<sup>1</sup>, <sup>1</sup>Kansas State University.

Cooking methods used for research should achieve the desired target temperature. The objective of our study was to evaluate the temperature variation of a MagiKitch'n electric belt grill (EBG), a Blodgett forced-air convection oven (FAC), and a Farberware<sup>®</sup> electric broiler (EB). The EBG was tested (two replications) at target temperatures of 71.1, 116.6, 162.8, and 208.9°C. Actual top and bottom platen temperatures were  $75.7 \pm 3.2$ ,  $75.7 \pm 4.1$ ;  $123.5 \pm 3.5$ ,  $124.7 \pm 4.0$ ;  $173.0 \pm 4.3$ ,  $174.5 \pm 4.4$ ; and  $222.6 \pm 5.5$ ,  $224.3 \pm 5.1$ °C, respectively. Linear regression analysis was used to develop equations for EBG top and bottom platens to correct for the temperature bias evident at each temperature (EBG top platen = target temperature  $\times .93 + 1.30$ ,  $R^2 = .99$ ,  $P<.001$ ; EBG bottom platen = target temperature  $\times .92 + 1.95$ ,  $R^2 = .99$ ,  $P<.001$ ). Adjusting the settings to achieve the target top and bottom platen temperatures resulted in the following temperatures:  $71.1 \pm 3.1$ ,  $71.4 \pm 3.6$ ;  $117.7 \pm 3.3$ ,  $118.6 \pm 4.0$ ;  $163.3 \pm 3.5$ ,  $163.7 \pm 4.1$ ; and  $210.1 \pm 3.7$ ,  $210.3 \pm 4.1$ °C, respectively. We found a 2-hr warm up period necessary to allow platen temperatures to equilibrate. The FAC oven was tested (two replications) at temperatures of 107.2, 162.8, and 218.3°C. Initial oven temperatures were  $104.4 \pm 1.8$ ,  $160.2 \pm 1.8$ , and  $217.7 \pm 1.7$ °C, respectively. Linear regression analysis of FAC oven temperatures provided an equation (FAC temperature setting = target temperature  $\times .98 + 5.37$ ,  $R^2 = .99$ ,  $P<.001$ ), which generated adjusted oven temperatures of  $107.2 \pm 1.5$ ,  $162.7 \pm 1.5$ , and  $218.5 \pm 1.3$ °C. However, the doors must be kept closed to attain this precision. The EB has no temperature control. Monitoring twelve locations on the EB (three replications) resulted in a mean value of  $118.4 \pm 20.3$ °C. However, temperature variation of  $90.2 \pm 12.4$  to  $144.9 \pm 10.2$ °C was observed on the EB, depending upon location. The FAC with the doors kept closed was very precise, as was the EBG after adjustments were made. These results suggest that each institution should validate the temperature of their respective cooking methods for accurate reporting of procedures.

**Key Words:** Cooking, Temperature, Methods

**118 Relationships among selected beef carcass characteristics.** T. Lawrence<sup>\*1</sup>, D. King<sup>1</sup>, T. Montgomery<sup>2</sup>, and M. Dikeman<sup>1</sup>, <sup>1</sup>Kansas State University, <sup>2</sup>West Texas A&M University.

Beef carcass data (adjusted fat thickness, cm {AFT}; hot carcass weight, kg {HCW}; longissimus muscle area, cm<sup>2</sup> {LMA}; USDA quality grade {QG}, percentage kidney-pelvic-heart fat {KPH}, USDA yield grade {YG}) from A maturity steers and heifers (n = 60,625) were analyzed to evaluate changes in QG by increasing AFT, differences in cutability indicators across QGs, and the association of HCW with LMA. Percentages of each QG (Standard {ST}, Select {SE}, Low Choice {LC}, Upper 2/3 Choice {UC}, Prime {PR}) and YG 4&5s by ascending fat thickness were calculated (results in data table). ANOVA of AFT, HCW, LMA, KPH, and YG by QG was significant ( $P < .01$ ) for each variable. Least squares means  $\pm$  SD for each variable by QG were: (AFT) ST =  $0.7 \pm 0.4$ , SE =  $1.1 \pm 0.4$ , LC =  $1.3 \pm 0.4$ , UC =  $1.5 \pm 0.4$ , PR =  $1.5 \pm 0.4$ ; (HCW) ST =  $326.2 \pm 41.0$ , SE =  $342.7 \pm 36.5$ , LC =  $346.3 \pm 35.7$ , UC =  $349.9 \pm 35.6$ , PR =  $350.3 \pm 33.8$ ; (LMA) ST =  $86.8 \pm 11.9$ , SE =  $85.2 \pm 10.2$ , LC =  $82.7 \pm 9.4$ , UC =  $81.8 \pm 9.0$ , PR =  $80.3 \pm$

8.5; (KPH) ST = 1.9 ± 0.5, SE = 2.1 ± 0.5, LC = 2.1 ± 0.5, UC = 2.2 ± 0.5, PR = 2.3 ± 0.5; (YG) ST = 2.0 ± 0.7, SE = 2.6 ± 0.7, LC = 3.0 ± 0.7, UC = 3.3 ± 0.7, PR = 3.4 ± 0.7. USDA REA requirements indicate a 17-cm<sup>2</sup> REA increase concurrent with a 100 kg increase in HCW (REA = HCW × 0.17 + 24.5). Our data suggest that an 11-cm<sup>2</sup> REA increase results from a 100 kg increase in HCW (REA = HCW × 0.11 + 45.21). QG improved with increasing AFT, but after 15mm AFT the percentage YG 4 & 5's increased dramatically faster than the percentage of Choice carcasses. The association between HCW and REA may differ from USDA requirements.

AFT,mm	n	%ST	%SE	%LC	%UC	%PR	%YG 4&5
0-1	655	23.2	61.1	14.9	0.8	0	0
2-3	1,002	18.1	62.0	18.0	1.7	0.2	0
4-5	3,645	10.4	58.9	26.9	3.6	0.2	0
6-7	5,011	6.6	60.5	28.9	3.8	0.2	0
8-9	9,729	3.6	55.2	35.2	5.8	0.2	0
10-11	8,868	1.8	47.9	41.1	8.8	0.4	0.2
12-13	10,061	1.3	38.7	47.2	12.0	0.8	0.7
14-15	9,678	0.6	31.3	49.2	17.9	1.0	3.5
16-17	5,816	0.5	27.7	49.0	21.3	1.5	11.9
18-19	3,411	0.3	25.8	48.6	23.1	2.2	29.2
20-21	1,237	0	25.4	47.4	25.5	1.7	59.3
22-23	713	0.6	22.8	48.3	26.5	1.8	78.8
24-25	447	0.2	21.5	50.5	25.1	2.7	90.8
26-27	155	0	19.3	51.0	28.4	1.3	95.5
>27	197	1.2	16.5	45.8	34.4	2.1	99.2

**Key Words:** Beef, Quality, Cutability

**119 Phenotypic relationships among intramuscular fat, serum testosterone, and scrotal circumference in yearling bulls.** D. W. Moser\*, T. T. Marston, J. D. Breinig, L. E. Wankel, and J. F. Gleghorn, *Kansas State University, Manhattan.*

Yearling bulls at the Kansas Bull Test (KBT, n=311) and the Kansas State University teaching herd (KSU, n=98) were ultrasonically scanned for body composition, measured for scrotal circumference (SC), and sampled for serum testosterone (T2) level. Composition measures taken were subcutaneous fat thickness (FT), *longissimus dorsi* muscle area (REA), and intramuscular fat percentage (IMF). Composition traits were analyzed as dependent variables with a linear model that included effects for age at measurement (AGE), SC, T2, breed, and location (KBT or KSU). Age, breed, location and SC significantly impacted all three measures of composition (P < .0001). T2 was a significant variable in the prediction of FAT (P < .0001). The regression of composition traits on SC was negative for FAT and IMF, but positive for REA. Removal of SC from the model had no impact on the significance of T2 relative to measures of composition. When T2 was analyzed as a dependent variable, SC was not a significant effect (P=.25). If ultrasonic measures of body composition taken on yearling bulls are to be used in genetic evaluations, such measures may need to be adjusted for the effect for scrotal circumference to accurately predict genetic effects for composition of fed steers and heifers.

**Key Words:** Body composition, Scrotum, Testosterone

**120 The effects of feeding elevated levels of vitamins D<sub>3</sub> and E on beef longissimus tenderness.** G.K. Rentfrow\*<sup>1,2</sup>, L. Berger<sup>1</sup>, T. Carr<sup>1</sup>, F. McKeith<sup>1</sup>, M.S. Brewer<sup>1</sup>, and E.P. Berg<sup>2</sup>, <sup>1</sup>University of Illinois, <sup>2</sup>University of Missouri.

Twenty-four yearling heifers (12 Angus and 12 Wagyu × Angus) and twenty-four 2-year-old heifers (12 Angus and 12 Wagyu × Angus) were used to evaluate the effects of feeding elevated levels of Vitamin D<sub>3</sub> and Vitamin E on beef Longissimus lumborum tenderness. Twelve heifers received 1g/ head of alpha-tocopherol acetate for 240 d, 12 received 7.5 million IU/ head/ d of Vitamin D<sub>3</sub> for 10d immediately prior to harvest, 12 were fed D<sub>3</sub>+E, and 12 served as controls (six yearling and six 2-year-olds in each treatment). Blood samples were collected 24 hrs preharvest via jugular puncture for serum Ca<sup>2+</sup> analysis. Warner-Bratzler shear force (WBS) and taste panel evaluation were determined on 2.54-cm thick steaks from the Longissimus lumborum (LL). Eight steaks (four WBS and four taste panel evaluation) were removed, and aged for 0, 7, 14, and 21 days. At the end of the aging period, steaks were frozen at

20 C until analysis could be performed. The data was analyzed utilizing the Mixed procedure of SAS with a model accounting for vitamin, year, breed, aging treatment, and two-way interactions. Taste panel, and WBS were analyzed with repeated measurement statement, with a Bonferroni adjustment. Vit D<sub>3</sub> and D<sub>3</sub>+E supplementation numerically (p<0.06) increased serum Ca<sup>2+</sup> levels. Serum Ca<sup>2+</sup> levels were numerically higher (p<0.06) in 2-year-old heifers. There were no significant differences between vitamin treatments for WBS. D<sub>3</sub>+E supplemented Angus heifers had higher (less tender) (p<0.03) LL WBS values when compared to other treatments and breeds. Vitamin E supplemented heifers received the highest (p<0.02) taste panel scores for tenderness (more tender) and juiciness (more juicy), while no significant differences were observed between other treatments. These results do not indicate that vitamin D<sub>3</sub> and D<sub>3</sub>+E has an affect on LL tenderness.

**Key Words:** Vitamin D<sub>3</sub>, Vitamin E, Tenderness

**121 Effects of halothane genotype, dietary magnesium, and duration of refrigerated storage on quality characteristics of vacuum-packaged pork loins.** J. K. Apple\*, M. R. Stivarius, J. Riemann, L. K. Rakes, and C. V. Maxwell, *University of Arkansas, Fayetteville, AR.*

Bone-in loins (n=72) from halothane negative (HH) and carrier (Hh) pigs fed diets supplemented with either 0, 1.25, or 2.5% magnesium mica (MM) were used to test the interactive effect, if any, of genotype and dietary magnesium on quality traits of vacuum-packaged pork during extended storage at 2 C. At 48 h postmortem, the blade and sirloin portions were removed, and loins were fabricated into 3 equal-length sections, vacuum-packaged, and assigned randomly to 0, 3 or 6 weeks of storage. At each allotted storage time, loins were removed from vacuum-bags and processed into longissimus muscle (LM) chops. A 2-g sample of LM was removed from the center of the loin section and homogenized in 20 mL of distilled, deionized water for pH measurements. Subjective and objective color data were collected on two 2.5-cm thick chops after a 45-min bloom period, and two 3-cm thick chops were used to measure drip loss percentages (DL%). Loins from pigs fed 2.5% MM had lower (P<0.05) pH values and marbling scores than pigs fed diets devoid of MM; otherwise, dietary MM had no (P>0.10) effect on pork quality. Muscle pH values for HH- and Hh-pigs were similar (P>0.10) at 0 and 3 weeks of storage; however, after 6 weeks of storage LM pH from HH-pigs was higher (P<0.05) than Hh-pigs. Chops from Hh-pigs had greater (P<0.05) DL% than chops from HH-pigs at 0 weeks of storage, but DL% were similar (P>0.05) after 3 and 6 weeks of storage. Both American and Japanese color scores for LM chops from Hh-pigs were lower (P<0.05) than HH-pigs at 0, 3, and 6 weeks of storage. Although LM from Hh-pigs was lighter (P<0.05) than the LM from HH-pigs at each storage time, L\* values for HH-pigs increased (P<0.05), while L\* values for Hh-pigs decreased (P<0.05), after 3 weeks of storage. Initially, LM from HH-pigs was redder (P<0.05) and less (P<0.05) yellow than the LM from Hh-pigs; however, a\* and b\* values were similar (P>0.10) after 3 and 6 weeks of storage. In agreement with previous results from our laboratory, long-term supplementation of swine diets with MM had no appreciable effect on pork quality during storage. Initial (0 week) pork color and water-holding capacity of Hh-pigs were inferior to HH-pigs; however, quality traits were similar among genotypes as storage was extended to 6 weeks.

**Key Words:** Halothane, Magnesium mica, Pork quality

**122 Effect of level, source and time of feeding prior to slaughter of supplementary magnesium on pork quality.** D. N. Hamilton\*<sup>1</sup>, A. V. Frampton<sup>1</sup>, M. Ellis<sup>1</sup>, F. K. McKeith<sup>1</sup>, and J. M. Eggert<sup>2</sup>, <sup>1</sup>University of Illinois at Urbana-Champaign, <sup>2</sup>Hubbard Feeds Inc..

This study investigated the effect of source, level, and time of feeding of supplementary magnesium on pork quality. A total of 144 barrows and gilts were utilized in a 2 × 3 × 3 factorial arrangement with an additional control treatment. There were two levels of magnesium (1.6 vs 3.2 g of Mg/pig/day), three sources of magnesium (sulfate vs dipropionate vs proteinate), three feeding durations (5 vs 2 vs 1 day prior to slaughter), and a control (no added magnesium). Pigs were placed in pens of two (1 barrow and 1 gilt) and given a one-week acclimation period and then placed on test. Animals were given ad libitum access to feed and feed disappearance was measured each day. Pigs were slaughtered

at approximately 110 kg live weight and fresh meat quality was measured on the longissimus. There was no effect of level, source, or time of feeding of magnesium on growth performance. Minolta L\* values were lower ( $P \leq 0.05$ ), indicating darker muscle color, for pigs supplemented 1.6 g Mg/pig/d compared to 3.2 g Mg/d. Animals supplemented at 1.6 g Mg/pig/d had significantly higher ( $P \leq 0.05$ ) ultimate pH and lower ( $P \leq 0.05$ ) Minolta L\* scores when compared to the control pigs. Pigs on the 1d magnesium treatment had the highest ( $P \leq 0.05$ ) ultimate pH compared to those on the 2 d, 5 d and control treatments. Minolta L\* values were lower ( $P \leq 0.05$ ) for pigs on the 5 and 1 d treatments when compared to the controls. Pigs on the 1 d treatment showed a trend towards a greater ( $P \leq 0.10$ ) subjective color score and a lower ( $P \leq 0.10$ ) drip loss percentage when compared to the control animals indicating darker meat with more water-holding capacity. Subjective color scores were greater ( $P \leq 0.05$ ) for pigs fed propionate and sulfate compared to those on the dipropionate diets. Sulfate and propionate treatments produced pork with the lower Minolta L\* values compared to the control ( $P \leq 0.07$ ). Pigs fed the sulfate diet tended to have a lower ( $P \leq 0.10$ ) drip loss compared to those on the control treatment. Results from this study suggest that magnesium sulfate produced the greatest improvement in meat quality traits of the three sources evaluated and that the lowest level (1.6 g Mg/pig/d) and the shortest time of supplementation (1 d) may be effective in improving pork color and water-holding capacity.

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

**123 Comparison of Warner-Bratzler shear force values and star-probe compression values in pork loin.** S. M. Lonergan<sup>\*1</sup>, K. J. Prusa<sup>1</sup>, C. A. Fedler<sup>1</sup>, J.K. Page<sup>1</sup>, and J. E. Cannon<sup>2</sup>, <sup>1</sup>Iowa State University, <sup>2</sup>DEKALB CHOICE GENETICS.

The objective of this study was to evaluate relationships between objective measures of tenderness and sensory texture attributes of pork loins. Sixty loins from Land O'Lakes, Inc. terminal cross pigs were obtained from a commercial packing plant. Loins were vacuum packaged one day postmortem and stored at 2C for 6 days. One chop (2.54 cm) was removed at the 10th rib region for sensory analysis. Four chops (2.54 cm) posterior to the sensory sample were removed for instrumental measures of texture. Lipid content was determined on samples taken immediately anterior to the sensory sample. Chops for sensory analysis, star-probe (SP; 2 chops) and Warner-Bratzler Shear force (WBS; 2 chops) from each loin were broiled to 71C in an electric oven broiler preheated to 210C. A trained sensory panel evaluated each sample for tenderness and chewiness. A ten-point scale was anchored on the left end with a term representing a low degree of tenderness and chewiness and the term on the right representing a high degree of tenderness and chewiness. Two chops were evaluated for instrumental texture using a circular, five-pointed star-probe attached to an Instron Universal Testing Machine (Model 1122). The star probe attachment was used to determine the amount of force needed to puncture and compress the chop to 80% of the sample height. Each chop was punctured 3 times. Two chops were evaluated for instrumental tenderness using a WBS attachment on a TA.XT2 Texture Analyzer (Texture Technologies Corp., Scarsdale, NY). Six 1.25 cm cores were taken from each chop parallel to the muscle fiber. The average of the six cores was recorded for each loin. SP and WBS were highly correlated ( $r=.675$ ;  $P<.01$ ). SP and WBS were also highly correlated ( $P<.01$ ) to sensory panel tenderness scores ( $r= -0.541$  and  $-0.548$  respectively) and chewiness scores ( $r= .619$  and  $.622$ , respectively). Significant correlations ( $P<.05$ ) for lipid content and WBS ( $r=-.286$ ), SP ( $r= -.296$ ) were detected; however, significant correlations between lipid content and sensory chewiness and tenderness were not observed. The results of the study suggest that WBS and SP measurements are related and can be used to predict sensory properties of tenderness and chewiness in pork.

**Key Words:** Pork Tenderness, Warner-Bratzler shear, Star Probe

**124 Utilization of real time ultrasound to predict intramuscular lipid and marbling in fresh pork loins.** S. M. Lonergan<sup>\*1</sup>, J. P. Carlson<sup>2</sup>, and L. H. Tichenor<sup>2</sup>, <sup>1</sup>Iowa State University, <sup>2</sup>Western Illinois University.

Intramuscular lipid contributes to overall eating quality of fresh pork. The objective of this trial was to determine the utility of ultrasound

image analysis in prediction of intramuscular lipid in pork. Cross sectional ultrasonic images of the longissimus dorsi were taken at approximately the tenth rib on 50 pigs of market weight at the Western Illinois University Swine Testing Station. Both purebred and crossbred animals were represented in the group, which were pigs entered by private individuals in the Illinois State Fair Classic competition. Thus the animals represented a wide range of genetic backgrounds. Two ultrasound technicians collected images on each pig. All images were taken one day prior to slaughter. A computer program specifically designed to analyze color shading was written to analyze the pixel fields of the images to determine the percent of pixels in a specific color range. Images were analyzed for pixel shading from a range of 140, which represented a small range of values between white and black, to a value of 70, which offered a much broader range of gray shades. A sample of the loin was taken from the 10-12th rib region for quality and composition analysis. Pork quality traits measured included pH at 24 h, subjective quality scores, Warner-Bratzler shear force (WBS), Hunter color values and lipid content. Intramuscular lipid ranged from 0.5 to 5.45 % and was significantly correlated ( $P < .01$ ) with loin firmness ( $r= .429$ ) and marbling score ( $r=.872$ ), but not with WBS measured on samples aged 5 days postmortem. Predicted lipid content from images collected by both ultrasound operators was not significantly correlated with WBS or color of pork loins. However, the correlation between marbling and predicted lipid content from ultrasound operator 1 approached significance ( $r=.273$ ;  $P < .10$ ). Similar relationships were not observed for the predicted lipid content from images collected by operator 2. Prediction of intramuscular lipid with ultrasound image analysis has potential applications in pork. However, it is clear that variation between ultrasound technicians must be reduced before this particular application can be utilized.

**Key Words:** Pork, Intramuscular Lipid, Ultrasound

**125 Effect of Paylean (ractopamine hydrochloride) on lean and primal cut yields from the pork carcass.** J. R. Wagner<sup>\*1</sup>, D. J. Jones<sup>1</sup>, and D. H. Mowrey<sup>1</sup>, <sup>1</sup>Elanco Animal Health (A Division of Eli Lilly and Company).

Paylean (ractopamine hydrochloride, Elanco Animal Health) is a swine feed ingredient that directs nutrients to increase the amount of quality lean meat in high value cuts and improves production efficiency. Paylean is indicated to increase carcass leanness. Data from four similarly designed carcass cut-out trials were pooled and analyzed to determine the effect of feeding Paylean at 0 (96 pigs) or 20 ppm (164 pigs) on cutting yields of pork carcasses. Pen was the experimental unit with 4 pigs per pen at two sites and 5 pigs per pen at the other two sites. Pigs were fed from approximately 68 kg to the target slaughter weight of 109 kg. Cutting yields were determined for the ham, loin, belly, picnic, and Boston butt as a percentage of the chilled carcass. The ham, loin, picnic and Boston butt were converted to untrimmed, trimmed bone-in, and trimmed boneless cuts. Results of the analysis are in the table. On an untrimmed basis, yield of ham increased ( $P<0.01$ ) and yield of the belly was slightly decreased ( $P<0.05$ ). Percent lean cuts were increased at each trimming level ( $P<0.01$ ) by feeding Paylean at 20 ppm. Differences in lean cut yields increased as the degree of trimming increased ( $P<.01$ ). These results indicate feeding Paylean at 20 ppm increases the total yield of the trimmed, boneless four lean cuts by 2.62 absolute percentage points.

	Yield	(Percent of Chilled Carcass)
	Control	Paylean, 20 ppm
Untrimmed (four-trial summary)		
No. of		
Experimental Units	23	37
Ham	26.16	26.89**
Loin	25.31	25.00
Shoulder	22.86	22.92
Belly	15.75	15.45*
Primal cut	90.08	90.26*
Lean cut	74.33	74.81**
Closely trimmed, bone-in (four-trial summary)		
No. of		
Experimental Units	23	37
Ham	23.45	24.50**
Loin	19.20	19.87**
Boston butt	11.02	11.20**
Picnic	8.09	8.37
Lean cut	61.76	63.84**
Trimmed, boneless (three-trial summary)		
No. of		
Experimental Units	17	34
Ham	17.74	18.92**
Loin	12.61	13.32**
Boston butt	6.98	7.39**
Picnic	8.06	8.30**
Lean cut	45.39	48.01**

\*Different from control (P<0.05) \*\*Different from control (P<0.01)

**Key Words:** Swine, Ractopamine, Lean cut yield

### 126 Factors affecting beef color development (bloom) over time. K. S. Kirchofer, C. R. Calkins\*, K. M. Es- ridge, and D. J. Hanson, University of NE, Lincoln.

To determine the factors which influence color development (bloom) in beef, the influences of chilling time, fat thickness and carcass weight on bloom of 118 beef carcasses varying in quality grade were determined in two commercial slaughter facilities which had different carcass chilling lengths prior to grading. Carcass selection relied on a grid which included carcass weight (<318 kg or >363 kg), 12th rib fat thickness (<1.01 cm or >1.78 cm), and quality grade (Select, low Choice, or upper 2/3 Choice). Color measurements were made at 0, 3, 6, 9, 12, 15, 18, 20, 30, 45, 60, and 90 min using a HunterLab MiniScan™ XE-Plus colorimeter. For each carcass, the change in color over time was estimated with a negative exponential growth model for a\* and b\*, and a simple linear regression model for L\* to determine the initial color, shape of response and ultimate color of each carcass. The R<sup>2</sup> approximations for these equations among quality grades were .3-16, 68-75 and 78-87% for L\*, a\*, and b\*, respectively. The estimated parameters for each carcass were then analyzed using an ANOVA for a completely randomized design with an incomplete factorial arrangement where the factors were plant (sub-grouped by plant and chill length), weight, fat thickness, and quality grade. These equations were influenced (P<0.05) by chill time (L\*, a\* and b\*), fat thickness (b\*), and weight (a\*). An equation to predict the change in variability of color measurements during bloom was created. The development of L\* over time was highly variable from one time period to the next, limiting accurate prediction of ultimate L\*. Initial a\* and b\* measurements (0 min) were 48 and 38% more variable than ultimate (90 min) color measurements; allowing 12 min (a\*) or 9 min (b\*) of bloom time reduced this variation to less than 10%. Beef color development is influenced by chill time, fat thickness, carcass weight, and quality grade. It appears 9-12 min of bloom time are needed to allow accurate prediction of ultimate lean color.

**Key Words:** Beef, Color, Bloom

### 127 Dietary fat source alters beef carcass tocopherol and fatty acid profiles. E. E. D. Felton\*<sup>1</sup>, C. L. Lorenzen<sup>1</sup>, C. A. Stahl<sup>1</sup>, M. S. Kerley<sup>1</sup>, S. D. Soderlund<sup>2</sup>, and F. N. Owens<sup>2</sup>, <sup>1</sup>University of Missouri, Columbia, MO, <sup>2</sup>DuPont Specialty Grains, Des Moines, IA.

Diets differing in source of lipid were compared to determine their effects on carcass tocopherol and fatty acid (FA) composition. Steers (n = 72) were fed either: 1) a corn/soybean meal diet (CON); 2) diet 1 but containing 16 % whole raw soybeans of a standard variety replacing all of the soybean meal; 3) diet 2 with the whole soybeans being high in oleic acid (HOB); or 4) diet 1 with choice white grease (CWG) added to provide an amount of fat equal to that supplied by soybeans of diets 2 and 3. Fatty acid profile of the diets differed (P < .06) in the degree of saturation and content of 14:0, 16:0, 16:1, 18:0, 18:1, 18:2 and 18:3. The CWG diet had the highest (P = .01) level of saturated FA, followed by CON, NORM and HOB. The HOB diet had a greater (P < .01) level of total monounsaturated fatty acids (MFA) than did the other treatments. NORM and CON diets had greater (P < .01) levels of polyunsaturated fatty acids (PUFA) compared to HOB and CWG. Longissimus dorsi (loin) samples taken from steers fed CON, NORM, and HOB were similar (P > .1) in α-tocopherol content. Steers fed CWG had lower (P < .1) α-tocopherol content than did the other treatments (0.79 vs. 0.99 ppm, respectively). Loin samples from HOB fed steers had the highest (P < .01) concentration (0.33 ppm) of γ-tocopherol followed by NORM, CON and CWG (0.25, 0.13 & 0.12 ppm, respectively). The tissue content of 14:0, 18:1, 18:2 and degree of FA saturation can be affected by diet. Loin samples from CWG fed steers had the lowest (P < .1) level of 14:0 followed by NORM, HOB and CON. Steers fed NORM had loin samples with the highest (P = .04) level of 18:2 and the lowest (P < .1) level of 18:1 as compared to the CON, HOB and CWG treatments. PUFA content was higher (P = .04) in the NORM loin samples than were the CON and HOB samples, but similar (P > .1) to the CWG samples. Loin samples from the NORM treatment had the lowest (P < .1) content of MFA. These data show that the source of dietary lipid can affect the α- and γ-tocopherol content as well as the FA composition of the beef carcass.

**Key Words:** Soybeans, Fatty Acids, Tocopherol

### 128 Dietary conjugated linoleic acid conserves color, decreases lipid oxidation, and changes fatty acid profile of irradiated beef patties. B. R. Wiegand\*<sup>1</sup>, F. C. Parrish, Jr.<sup>2</sup>, J. E. Swan<sup>3</sup>, S. T. Larsen<sup>2</sup>, A. H. Trenkle<sup>2</sup>, and K. Gassman<sup>2</sup>, <sup>1</sup>Illinois State University, Normal, IL, <sup>2</sup>Iowa State University, Ames, IA, <sup>3</sup>Elanco Animal Health, Greenfield, IN.

Continental-cross steers (n=30) weighing 360 kg were fed conjugated linoleic acid (CLA) formulated with calcium salts at 0, 1.0, and 2.5% of the diets. Steers were assigned to dietary groups by live weight and ultrasound 12th rib fat depth. After an average of 130 d on feed, steers were slaughtered and ground beef patties (90/10) from the semimembranosus were analyzed for Hunter color (L\*, a\*, b\*), thiobarbituric acid values (TBA), fatty acid profile, and CLA concentration. An increase in Hunter L\* values with 2.5% CLA was observed in the control and irradiated patties. An increase also was detected in hunter a\* values with 2.5% CLA in irradiated patties. Hunter b\* values with 2.5% CLA increased in both control and irradiated patties. Results indicated an increase in saturated (14:0, 16:0, and 18:0) fatty acid percentage and a subsequent decrease in unsaturated (18:1 and 18:3) fatty acid percentages in randomly sampled beef patties within each diet group. In contrast to other reports, no changes were observed for arachadonic acid (20:4) with dietary CLA. TBA (lipid oxidation) values decreased with 1.0 and 2.5% CLA compared to controls in non-irradiated and irradiated patties. The decrease in TBA values is likely a result of a shift toward more saturated fatty acids (as determined by gas chromatography) of beef from CLA-supplemented steers. This could cause fewer unsaturated fatty acids to be available for lipid oxidation and less malonaldehyde production would result in lower TBA values. Also, TBA values were similar for irradiated versus non-irradiated beef within a CLA-diet group. Furthermore, the GC analysis of FAMES, as compared to known CLA standards, showed a linear increase of the trans-9, trans-11 CLA isomer with increasing levels of dietary CLA. No other CLA isomer experienced significant change in concentration with dietary CLA supplementation. This study shows dietary CLA decreases the loss of red color, shifts fatty acid profile to a more saturated product, and decreases lipid oxidation in irradiated ground beef.

**Key Words:** conjugated linoleic acid, irradiation, beef patties



**129 Comparison of ultrasound and carcass measures to predict lean beef from four primal cuts.** R. G. Tait, Jr\*, G. H. Rouse, D. E. Wilson, and C. L. Hays, *Iowa State University, Ames, IA.*

Lean yield in the four primals is one of the most economically important traits for the beef industry. The most widely used system to predict this trait is USDA yield grade. The purpose of this study was to determine if routine ultrasound measures and additional rump measures could be used to more accurately predict the percent lean from the four primals than carcass measures. This study utilized market cattle (n=265) consisting of Angus bulls, Angus steers, and crossbred steers. The right side of each carcass was fabricated into retail cuts, lean trim, fat, and bone and weights of each component were recorded. Lean from the four primals was then expressed as a percentage of side weight. Traditional carcass measures collected were: 1) hot carcass weight (HCW), 2) 12-13<sup>th</sup> rib fat thickness (CFAT), 3) 12-13<sup>th</sup> rib ribeye area (CREA), 4) percent kidney, pelvic, and heart fat (KPH). Live animal ultrasound measures collected within seven days prior to harvest were: 1) scan weight (SCANWT), 2) 12-13<sup>th</sup> rib fat thickness (UFAT), 3) 12-13<sup>th</sup> rib ribeye area (UREA), 4) subcutaneous fat thickness over the termination of the biceps femoris in the rump/reference point (URFAT), 5) depth of gluteus medius under the reference point (URDEPTH), 6) area of gluteus medius anterior to the reference point (URAREA). A step-wise regression was performed to develop models to predict percent lean from the four primals based on carcass measures or ultrasound measures, and comparisons were made between the models. Significant measures (p<.10) for the carcass data were CFAT, CREA, and KPH with a model R<sup>2</sup> = .3842. Significant measures (p<.10) for the ultrasound data were UFAT, UREA, SCANWT, URAREA, and URFAT with a model R<sup>2</sup> = .4281.

**Key Words:** Beef, Ultrasound, Lean Yield

**130 Evaluation of serially measured live-animal traits in purebred Angus bulls and heifers.** A. Hassen\*, D. E. Wilson, and G. H. Rouse, *Iowa State University, Ames, IA.*

This study utilized 428 purebred Angus bulls and heifers born during 1998 and 1999 at Rhodes beef research farm. Animals were ultrasonically scanned four to six times for back fat thickness (BKF), rump fat thickness (RMF), percentage of intramuscular fat (PFAT), and longissimus muscle area (LMA). Body weight (WT) and hip height (HT) measures were also recorded during all scan sessions. The objective of the study was to evaluate differences in growth and composition of bulls and heifers based on pooled data and individual animal regressions. Mean age of progeny at the first scan was 247 d for bulls and 264 d for heifers. Bull progeny were heavier (268 kg) at the first scan than heifers (255 kg). Analysis of data by scan session showed important (P < .05) effects of sex for most of the traits considered. Heifers were fatter than bulls for all measured fat related traits including PFAT, BKF, and RMF. However, bulls showed larger least squares means for WT, HT, and LMA measures than heifers. Analysis of data using repeated measures models showed a significant (P < .05) interaction between sex and the linear and quadratic effects of age indicating the limitations in using pooled estimates to describe growth and compositional changes in bulls and heifers. Individual animal regression parameters showed important (P < .05) sex differences in the intercepts and slopes of growth equations. Bull least squares means for LMA, HT, and WT slopes were .24 cm<sup>2</sup>/d, .04 cm/d, and 1.61 kg/d, respectively. The corresponding values for heifers were .18 cm<sup>2</sup> /d, .03 cm/d, and 1.18 kg/d, respectively. Least squares means for heifer FTK, RMF, and PFAT slopes were, .035 mm/d, .030 mm/d, and .009 %/d, respectively. The corresponding values for bulls were, .029 mm/d, .024 mm/d, and .004%/d, respectively. Regression parameters from individual animal regression averaged by sex may provide a better description of growth patterns in bulls and heifers than estimates from pooled data.

**Key Words:** Cattle, Growth, Ultrasound

**131 Comparisons of three cooking methods used for beef tenderness research.** T. E. Lawrence\*<sup>1</sup>, D. A. King<sup>1</sup>, E. Obuz<sup>1</sup>, E. J. Yancey<sup>1</sup>, and M. E. Dikeman<sup>1</sup>, <sup>1</sup>*Kansas State University.*

Cooking of research steaks is often assumed to be a controlled process that neither creates nor eliminates experimental variation in tenderness. Our objective was to compare several research cooking methods. Five

muscles from USDA Select beef carcasses were cooked on an electric belt grill (EBG) at three temperatures (93, 117, 163°C), in a forced-air convection oven (FAC) at 163°C, and on an electric broiler (EB; no temperature control) to determine effects of cooking treatment and muscle on Warner-Bratzler shear force values, cooking variables, and repeatability of duplicate measurements. All treatments allowed shear force differences to be detected (P < 0.05) among the five muscles, although differences were inconsistent. Neither longissimus lumborum nor semitendinosus shear values differed among the five cooking treatments, indicating that each muscle can be compared across the three cooking methods. However, shear values for biceps femoris, deep pectoralis, and gluteus medius differed (P < 0.05) among cooking treatments. In general, cooking times were longer and cooking losses were higher for the EB treatment. Endpoint cooked temperature did not differ across muscles within each cooking treatment. Post-cooking temperature rise of all muscles was higher (P < .05) for the BG163 treatment than for the BG 93, FAC and EB. Endpoint cooked temperature repeatability was not acceptable (R<sub>g</sub> ≥ .60) for any muscle cooked by any treatment. BG cooking resulted in the highest shear force repeatability (R = .70 to .89) for longissimus lumborum. All cooking methods provided acceptable (R<sub>g</sub> ≥ .60) repeatability of shear values for biceps femoris and semitendinosus. Repeatability estimates for longissimus lumborum were acceptable for all cooking methods except the FAC (R = .50). Based on poor repeatability (R = .09 - .66), the gluteus medius probably should not be used to test treatment effects on shear force values. The EB was the only cooking treatment that resulted in acceptable repeatability of shear force measurements for all five muscles.

**Key Words:** Beef, Repeatability, Tenderness

**132 Increasing the Value of the Beef Chuck by Altering the Rib/Chuck Break Point.** B. J. Reuter\*, D. M. Wulf, B. C. Shanks, J. M. Bok, and R. J. Maddock, *South Dakota State University, Brookings, SD.*

The objective of this project was to determine if the rib/chuck break point could be altered in order to increase the value of the beef chuck. Rib/chuck rolls (RCR) (n = 30) consisting of the ribeye roll and chuck eye roll subprimals (2nd through 12th rib locations) were cut into 22 steaks each (2 steaks per rib location), and Warner-Bratzler shear force and consumer purchase preference were evaluated for each rib location. Steaks from different locations of the RCR were comprised of differing proportions of several muscles: longissimus muscle (LM), spinalis dorsi and multifidus dorsi (SM), and complexus (CO). The LM (4th rib to 12th rib) contained three tenderness regions: 7th rib through 12th rib, 5th and 6th ribs, and 4th rib regions (lowest, intermediate, and highest shear force values, respectively; P < 0.01). Shear force differed (P < 0.05) among rib locations for the SM (2nd rib to 9th rib), but no logical pattern was evident. The CO (2nd rib to 7th rib) was more tender toward the anterior end (P < 0.05). The region of the RCR represented by the 4th through 6th rib locations had steaks with higher weighted-average shear force (average shear force of each steak, weighted for surface area of each muscle) values as compared to the rest of the RCR (P < 0.02). Animal-to-animal variation in shear force was 36% greater than rib-to-rib variation in shear force; thus, statistically significant differences in tenderness among rib locations may be undetectable by consumers. Steaks (n = 330) were offered for sale at a retail supermarket and case time was monitored on each steak to determine consumer purchase preference. Steaks from the 2nd through 4th rib locations required more time to sell (P < 0.01) and resulted in a greater number of "pulls" as compared to steaks from the 5th through 12th rib locations. Two alternative locations for the rib/chuck break point could be: between the 6th and 7th ribs yielding a cut useful in marketing a "premium quality" product or between the 4th and 5th ribs yielding four more ribeye steaks per carcass.

**Key Words:** Rib, Chuck, Fabrication

**133 Preliminary carcass, yield, and Warner-Bratzler shear force traits of topcross steer progeny of Hereford, Angus, Red Angus, Simmental, Gelbvieh, Limousin, and Charolais sires.** T. L. Wheeler\*, S. D. Shackelford, L. V. Cundiff, and M. Koohmaraie, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

Data were obtained on carcasses of 368 (291 for retail product yield and shear force) steers born in the spring of 1999 from artificial insemination matings of Hereford (H), Angus (A), Red Angus (RA), Simmental (S), Gelbvieh (G), Limousin (L), and Charolais (C) bulls to Hereford, Angus, and composite MARC III cows. Data were adjusted to a constant age of 448 d. Least squares means and mean least significant differences (LSD 0.05) are shown for hot carcass weight (HCWT), adjusted fat thickness (AFT), longissimus area (REA), USDA yield grade (YG), retail product weight and yield (RP, estimated from wholesale rib dissection), marbling score (MARB, small = 500 to 599), and 14 d postmortem Warner-Bratzler shear force value (WBS). Data indicate that carcasses from RA- and A-sired steers had the highest ( $P \leq 0.05$ ) marbling scores. Carcasses from L-, G-, C-, and S-sired steers had the highest ( $P \leq 0.05$ ) percentage of retail product. Longissimus from carcasses of A-sired steers had lower ( $P \leq 0.05$ ) shear force values than did C-, and G-sired steers. Differences in carcass yield, marbling, and shear force values among seven of the most common breeds in the U.S. could be used by producers to select breeds or crosses to meet their production targets.

Trait	RA	A	H	C	S	G	L	LSD 0.05
N	52	59	50	53	52	49	53	
HCWT, kg	374	378	371	383	387	375	370	NS
AFT, cm	1.5	1.5	1.4	1.1	1.1	1.0	1.0	0.3
REA, cm <sup>2</sup>	82.1	88.5	82.8	86.7	87.8	87.7	90.7	4.8
YG	3.6	3.2	3.3	3.0	3.0	2.8	2.6	0.4
RP, kg	216	223	220	238	241	234	230	10
RP, %	57.7	58.9	59.5	62.2	62.2	62.4	62.9	1.6
MARB	589	577	538	517	536	514	507	32
WBS, kg	4.1	3.8	4.0	4.3	4.0	4.4	4.1	0.4

**Key Words:** Beef, Breed, Quality

**134 Determination of moisture loss from fresh, aged, or frozen pork loin chops.** C. R. Taylor\*, T. D. Bidner, J. L. Shelton, L. L. Southern, and M. A. Persica, *Louisiana State University Agricultural Center, Baton Rouge.*

A study was conducted to compare drip loss, thaw loss, and cook loss of fresh, aged, and frozen pork loin chops. Six 2.54-cm chops (fourth to the tenth rib) were obtained from the left loin of 26 crossbred gilt carcasses 24 h after slaughter. Drip loss was determined by suspending the chop for 48 h in a Whirl-Pak bag. Thaw loss was determined by thawing the frozen chops for 24 h at 2 C then blotting to remove excess moisture. Cook loss was determined by cooking each chop to an internal temperature of 70 C then blotting to remove excess moisture. The boneless chops were allotted to six treatments (26 replications) in a completely

randomized design. The treatments were: 1) drip loss followed immediately by cook loss (DC), 2) drip loss, thaw loss (24-h freeze at -20 C), followed by cook loss (DTC), 3) cook loss of fresh chop (FC), 4) cook loss after a 5-d aging period at 2 C (AC), 5) thaw loss (fresh chop frozen for 24 h at -20 C), 6) thaw loss (fresh chop frozen for 35 d at -20 C). There was no difference ( $P > 0.10$ ) in drip loss between the DC chops and the DTC chops. Cook loss was decreased ( $P < 0.05$ ) in DTC chops relative to the DC, FC, or AC chops indicating that the 24-h freeze-thaw had an effect on cook loss. Cook loss was not affected ( $P > 0.10$ ) by the 5-d aging period relative to fresh chops (FC vs. AC). Thaw loss was reduced ( $P < 0.01$ ) in the chops frozen for 24 h relative to those frozen for 35 d. When comparing all chops that were cooked, overall loss was less ( $P < 0.01$ ) in FC than in DC, DTC, or AC chops. Overall loss was increased ( $P < 0.05$ ) in DTC chops relative to the FC or AC chops. These data indicate that a 48-h drip loss, followed by freezing, results in the lowest cook loss because of less free water, but the greatest overall loss, and that aging has no effect on cook loss. Furthermore, cooking fresh chops results in the lowest overall loss. Aging, freezing, and length of freezing time all had an influence on moisture loss.

**Key Words:** Pork Quality, Moisture Loss, Loin Chops

**135 Antibiotic resistance profiles of *Campylobacter* isolated from swine.** R. B. Harvey\*, M. E. Hume, R. E. Droleskey, R. C. Anderson, and D. J. Nisbet, *USDA, ARS, Food and Feed Safety Research Unit, College Station, TX USA.*

The purpose of the present study was to compare the genetic diversity and antibiotic sensitivity of *Campylobacter* spp. isolated from sows and piglets. During a single sampling period, five rectal swab samples were collected from each of three sows and 17 piglets that were housed in the same farrowing barn. Pure cultures of *Campylobacter coli* (confirmed by PCR) were isolated from swabs. Pulsed field gel electrophoresis was used to examine the genotypic patterns of 99 isolates. Antibiotic sensitivity tests (disk diffusion) were performed on each isolate. The categories of antibiotic susceptibility consisted of resistant, intermediate, and sensitive. The ten antibiotics tested were: amikacin, ampicillin, ciprofloxacin, clindamycin, erythromycin, gentamicin, lincomycin, neomycin, tetracycline, and tobramycin. Multiple genotypes were present in at least 50% of the samples. There appeared to be little correlation between genotypes of sows and those of piglets. The greatest antibiotic sensitivities were seen with amikacin (84%), ciprofloxacin (92%), clindamycin (75%), and erythromycin (100%). The greatest resistance observed was with lincomycin (100%), tobramycin (100%), neomycin (96%) and ampicillin (92%). There were 44% of the isolates resistant to gentamicin whereas 56% were in the intermediate category. Although ciprofloxacin, a fluoroquinolone antibiotic, is not available for use in swine production, 8 of the isolates were intermediate in resistance to that antibiotic. Often, there were substantial differences between the antibiotic sensitivities of isolates from sows when compared to those from piglets. These results indicate that multiple genotypes may occur simultaneously in the same animal and that a variety of antibiotic resistance patterns exist for *Campylobacter* isolates.

**Key Words:** *Campylobacter*, Piglet, Antibiotic sensitivity

**NONRUMINANT NUTRITION**

**136 Effects of dietary lactation lysine level, lysine source, and dextrose on sow and litter performance.** J.C. Peters\* and D.C. Mahan, *The Ohio State University, Columbus.*

A study evaluated the effects of dietary lysine level, lysine source and dextrose on lactating sow and litter performance. Seventy-four sows involving 192 farrowings over 4 parities were used in a 3 x 2 factorial experiment, conducted in a RCB design. The first factor evaluated 3 dietary lysine levels during lactation. A basal level was formulated to meet the sow's NRC lysine requirement (0.90%) for both primiparous and multiparous sows. Primiparous sows were fed the basal level or 0.30% added lysine from SBM or a combination of 0.18% lysine from SBM and 0.12% synthetic lysine. During parities 2 through 4, the basal level contained 0.90% (total) lysine, but the 2nd and 3rd treatment groups were fortified with either 0.15% lysine from SBM or synthetic lysine. The second factor evaluated dietary dextrose levels (0 or 10%). Lactation length was 21 d for primiparous sows and 17 d for multiparous sows. Body weight and BF measurements were collected during

lactation. Lysine level and lysine source had no effect on sow BW, BF, lactation feed intake, or litter performance at weaning. Plasma urea nitrogen concentrations were lower when synthetic lysine was added to the diets ( $P < 0.01$ ). Fat and protein composition of colostrum and milk, return to estrus interval and subsequent litter size (total and live) were not affected by their dietary lysine level and source fed during the previous lactation. The addition of 10% dextrose to the lactation diet did not affect sow or litter performance, except for a trend towards higher total lactation feed intake ( $P < .10$ ). The results suggest that feeding lysine levels above NRC recommendations does not improve sow or litter performance, lactation feed intake or subsequent reproductive performance at this level of production and when sows were fed either natural or synthetic lysine.

**Key Words:** Sow, Lactation, Lysine

**137 Effect of dietary lysine deficiency and valine excess on mammary protein metabolism in lactating sows.** X. Guan<sup>1</sup>, B. J. Bequette<sup>2</sup>, P. K. Ku<sup>1</sup>, and N. L. Trottier<sup>\*1</sup>, <sup>1</sup>Michigan State University, East Lansing, <sup>2</sup>Rowett Research Institute, Aberdeen, Scotland.

Nine multiparous lactating sows (Landrace x Yorkshire) were used to examine changes in mammary protein synthesis (PS), breakdown (PB) and net protein balance (NPB) (secreted plus constitutive proteins) in response to lysine (Lys) deficiency or valine (Val) excess. Sows were provided ad libitum access to one of three diets varying only in Lys and Val concentration (g/kg diet, analyzed), respectively: Lys-deficient (LD; Lys=4.93; Val=9.87), control (C; Lys=9.71; Val=10.15), and Val-excess (VE; Lys=9.76; Val=13.37). Dietary methionine (Met) content was kept constant (3.26 g/kg diet). On d 18 of lactation, a mixture of [2-<sup>15</sup>N]-Lys·HCl, [methyl-<sup>2</sup>H<sub>3</sub>]-Met, and [1-<sup>13</sup>C]-Val was continuously infused I.V. for 20.5 h. Arterial and mammary venous blood samples were obtained every hour and milk every two hours during the last 6 h of isotope infusion. A three-pool model, based on Met kinetics, was used to estimate mammary PS, PB and NPB, and casein enrichment at plateau was assumed to represent the intracellular precursor pool. Estimated rates of PS in LD compared to C (583.3 vs 975.1 g/d) and PB (229.5 vs 399.6) were decreased (P < .05), resulting in a decrease (P < .01) in NPB (353.7 vs 575.5 g/d) by the gland. Mammary PS was not different in VE compared C (787.1 vs 975.1 g/d) but PB was decreased (P < .05) (243.1 vs 399.6 g/d). Mammary NPB was not different in VE compared to C (544 vs 575.5 g/d). Dietary regime did not affect the partition of Val between mammary PS (66 %) and oxidation (34 %). Model estimates of NPB were not different from actual rates of milk protein yield plus estimated mammary growth. This study validates the arterio-venous kinetic model for estimating protein and amino acid metabolism by the mammary gland of lactating sows and the use of the model to examine the relative roles of limiting amino acids in regulating mammary protein metabolism.

**Key Words:** Mammary gland, Protein metabolism, Amino acid

**138 Plasma prolactin, glucose, and amino acid concentration response to dietary arginine supplementation in the lactating sow.** J. Perez Laspiur<sup>\*1</sup>, C. Farmer<sup>2</sup>, P. K. Ku<sup>1</sup>, and N. L. Trottier<sup>1</sup>, <sup>1</sup>Michigan State University, East Lansing, <sup>2</sup>Agriculture and Agri-Food Canada, Lennoxville, Quebec.

As previously reported (Perez Laspiur et al. 2000) dietary L-arginine (Arg) supplementation enhanced nutrient utilization during lactation for sows in a thermoneutral environment. Voluntary feed intake (P < 0.05) and weight change of sows (P < 0.10) decreased with increasing dietary Arg concentration. We hypothesized that Arg increased lactation efficiency by stimulating the secretion of metabolic and lactogenic hormones. Sixty-six (Landrace x Yorkshire) multiparous lactating sows were used in a 2 x 3 factorial design to determine the interactive effect of environmental temperature and Arg supplementation on plasma prolactin, glucose, and amino acid concentration. Sows were provided ad libitum access to one of three diets containing different Arg concentrations (g/kg diet) and Arg to Lys ratios, respectively: 9.6 g and 1:1; 13.4 g and 1.4:1; 17.3 g and 1.8:1. Sows were housed at 20° C (C: thermoneutral) or 30° C (HS: heat stressed). Arginine supplementation (n = 36) increased plasma Arg concentration (P < 0.01) and had no effect on plasma Lys concentration (P > 0.10). No interactive effect of dietary and environmental treatment was found on plasma amino acid concentrations. Plasma prolactin concentration (n = 42) was not affected by Arg supplementation (P > 0.10) or environmental treatment (P > 0.10). Plasma glucose concentration (n = 42) was increased (P < 0.10) by increasing dietary Arg concentration. Plasma glucose concentration increased (P < 0.01) in HS sows compared to C sows. Dietary Arg supplementation did not affect plasma prolactin concentration. Glucose metabolism was affected by Arg supplementation. Improved lactation efficiency observed with Arg supplementation cannot be explained by prolactin action, but results on plasma glucose indicate that insulin and growth hormone may be involved.

**Key Words:** Arginine, Prolactin, Glucose

**139 Evaluating nutrient dense and nutrient dense-low phytic acid corns with the addition of phytase for lactating sows.** K. A. Bowers<sup>\*</sup>, C. J. Kendall, and B. T. Richert, Purdue University, West Lafayette, IN.

One hundred and thirty-three Yorkshire x Landrace sows (avg. parity = 2.7) were used in a 22.3 d lactation experiment to evaluate the effects of corn type and phytase on sow and litter performance. Dietary treatments were: 1) nutrient dense corn (ND)-soy diet formulated to .35% available phosphorous, .9% Lys; 2) diet 1 with supplemental phytase (480 phytase units (PU)/kg); 3) nutrient dense-low phytic acid corn (LPA) substituted on an equal percentage basis for ND corn in diet 1; and 4) diet 3 with 480 PU/kg supplemental phytase. Sows were started on diets on d 0 post-farrowing and grouped by parity (1, 2-4, 5+) to form 3 lactation parity groups and into spring and summer months to form 2 seasonal periods. Sow weight, last rib, tenth rib, and last lumbar backfat depths were taken at d 0, 14, and weaning. Litter weights were taken at d 2 (after cross-fostering), 14, and weaning. Weekly feed intakes were measured and sow blood samples were collected at d 18. Nutrient digestibility was determined using 6 parity 1 females/trt that were fed chromic oxide marked diets. Fecal and urine samples were collected for 3 days between d 13 and 18 of lactation with milk samples collected on d 18. Corn type and phytase addition were used as independent variables with d 2 litter size, sow parity, days of lactation, and season used as covariates. Mean d 2 litter size was 10.5 pigs. Number of pigs weaned was not affected by treatment (avg. 9.78; P>.50) and there were no corn type by phytase interactions for any response criteria. Sows fed LPA corn had greater litter weaning weights (64.8 vs. 61.3 kg; P<.01), litter weight gain from d 2 to weaning (46.3 vs. 42.9 kg; P<.01), litter weight gain from d 14 to wean (20.3 vs. 18.4 kg; P<.04), and ADFI from d 0 to weaning (4.85 vs. 4.53 kg; P<.033) than sows fed ND corn. Sows weaning 10+ pigs (20 sows/trt) fed LPA corn had heavier litters at weaning (69.4 vs. 63.9 kg; P<.002) and increased litter weight gain from d 2 to weaning (50.0 vs. 44.6 kg; P<.003) than sows fed ND corn. In conclusion, LPA corn improved sow lactational performance, however there were no benefits displayed by the sows and their litters when phytase was added to the diets during lactation, irrespective of corn type.

**Key Words:** Sows, Low phytic acid corn, Phytase

**140 Effect of reduced dietary Cu, Zn, Fe, and Mn on reproductive performance of sows.** W.L. Flowers<sup>\*1</sup>, J.W. Spears<sup>1</sup>, and G.M. Hill<sup>2</sup>, <sup>1</sup>North Carolina State University, Raleigh, <sup>2</sup>Michigan State University, East Lansing.

The present study examined the effect of reducing dietary levels of Zn, Cu, Fe and Mn on the reproductive performance of sows. Crossbred gilts (n = 216) were used in three replicates. For each replicate, gilts (n = 72) were blocked by weight and received one of three supplemental treatments from 65 d of age through their third lactation. The inorganic control group received 15, 100, 100 and 40 ppm of Cu, Zn, Fe, and Mn, respectively. The reduced inorganic and reduced chelated treatments consisted of 5, 25, 25, and 10 ppm of Cu, Zn, Fe, and Mn, respectively. In the reduced inorganic treatment, 100% of the supplemental minerals were from inorganic sources, while in the reduced chelated treatment 50% of these minerals were metal proteinates. Females that did not conceive or failed to exhibit estrus within 7 d after weaning were removed from the study. A parity by treatment interaction (P = .04) was present for farrowing rate. There was no difference (P = .43) among parity 1 (52/59), 2 (36/43), or 3 (33/35) for sows receiving the reduced inorganic treatment. In contrast, a greater proportion of sows farrowed (P < .05) in parity 3 than 2 in the inorganic control (33/35 vs. 37/48) and reduced chelated treatments (27/29 vs. 30/38). Parity (P < .01) and treatment (P < .05) affected numbers of pigs born alive and weaned. Parity 3 sows had larger litters (11.1 vs. 9.4) and weaned more pigs (9.7 vs. 8.5) than parity 1 sows. Numbers of pigs born alive and weaned were greater for sows receiving the reduced inorganic treatment (10.6 and 9.4) compared with those fed the inorganic control (9.5 and 8.5) or reduced chelated (9.7 and 8.6) diets. Litter weaning weights were similar (P > .57) between the two reduced treatments, but higher (P < .05) than those in the inorganic control group. In summary, in this study, the reduction of dietary levels of supplemental inorganic Cu, Zn, Fe and Mn did not have a negative impact on reproductive performance of sows.

**Key Words:** Swine, Minerals, Reproduction

**141 Effect of early-weaning (14 vs 19 d) on sow lactation performance during heat stress. I. Tissue loss, milk production, and subsequent reproduction.** J. D. Spencer\*<sup>1</sup>, R. Cabrera<sup>2</sup>, R. Graves<sup>2</sup>, R.D. Boyd<sup>2</sup>, J. Vignes<sup>2</sup>, and G.L. Allee<sup>1</sup>, <sup>1</sup>University of Missouri-Columbia, <sup>2</sup>PIC USA.

To determine how lactation length changes the response to heat stress on sow performance to weaning and subsequent reproduction, 39 first and 100 two plus litter PIC C 22 females were used in a 2x2 factorial arrangement: 14 vs. 19 d wean, 21 vs 32°C. All sows were fed the same diet (1.07% total lysine, 3365 kcal ME/kg), and all litters were standardized to 10-11 pigs/litter. Body weight (BW), real-time ultrasound backfat (BF) and loin eye area (LEA) were taken at farrowing and weaning (14 or 19 d). Milk was analyzed on ten 3+ parity sows in both environments on days 0, 5, 10, 15, and 19 of lactation. Heat stress reduced feed intake 40% compared to sows lactating in 21°C (P<.05). For heat stressed sows, 19 d lactation increased BW loss 64% over 14 d (P<.05). Parity 1 females lost more BF than 2+ sows in both environments and lactation lengths (2.7 vs 1.6 mm) (P<.05). However, first litter and 2+ sows both lost 13% and 74% more BF (P<.07), respectively, and more than twice as much LEA (P<.05) when lactating for 19 d in heat stress. Milk yield decreased by 30% in the 32°C environment (P<.05), but milk composition was identical (P>.10). However, 32°C sows had elevated levels of cortisol in their colostrum (45 vs 25 ng/ml) (P<.05). Heat stressed gilts weaned on d-14 returned to estrus sooner (9.2 vs 22.8 d) than gilts lactating for 19 d (P<.10) in heat stress. Heat stress decreased subsequent litter size (P<.05) for both first litter and 2+ sows. Although 14 d weaning appeared to compromise subsequent litter size for 2+ sows lactated at 21°C (10.68 vs 11.53), the opposite response appeared to occur in gilts and 2+ sows weaned on d-14 under heat stress (14 d: 9.23, 10.45 vs 19 d: 8.18, 9.75, respectively). This study shows that reduced lactation length is a powerful method of reducing the impact of extreme heat stress on sow tissue loss and future reproductive performance, especially in the first litter female.

**Key Words:** Sow, Lactation, Heat stress

**142 Effect of early-weaning (14 vs. 19 d) on sow lactation performance during heat stress. II. Effect of milk replacer on piglet growth to weaning and 66 d of age.** J.D. Spencer\*<sup>1</sup>, R. Cabrera<sup>2</sup>, R. Graves<sup>2</sup>, R.D. Boyd<sup>2</sup>, J. Vignes<sup>2</sup>, and G.L. Allee<sup>1</sup>, <sup>1</sup>University of Missouri-Columbia, <sup>2</sup>PIC USA.

The benefit of using a milk replacer (MR) to enhance pig weaning weight (PWW) was studied with 139 PIC C 22 mixed parity females (1 or 2+). A 2x2 factorial arrangement of room temperature (21°C or 32°C) and sow lactation length (14 or 19 d) was used. Thus, pigs were either sow-reared to 19 d or early weaned at 14 d and reared to 19 d by MR (Advanced Birthright Nutrition®). MR was made available at d 10 to acclimate pigs prior to weaning. Pig weights were taken on d-19, and after a 47-d nursery period. Piglets from first litter and parity 2+ sows provided MR under heat stress had a heavier PWW than piglets nursing the sow to 19-d (MR-7.38 and 8.14 vs. 5.58 and 6.05 kg, respectively; P<.05). On d 14, pigs in 32°C were lighter (4.5 vs 5.12 kg/pig; P<.05) than those in 21°C. By d 19, PWW of pigs receiving MR in 32°C was similar to those provided MR in 21°C (7.98 vs 8.34 kg/pig; P>.10). MR reduced the difference normally observed in PWW between first litter and 2+ reared pigs (sow: 6.29 vs. 7.74 kg/pig at d 19) vs.(MR; 7.72 vs. 8.1 kg/pig at d 19) at 21°C. Over 70% of the pigs provided MR in both the control and 32°C had PWW above 6.8 kg. Only 50 and 27% of the pigs nursing sows for the entire 19-d had final PWW above 6.8 kg in 21 and 32°C environments, respectively. During the nursery period, parity 2+ reared pigs had a higher ADG (P<.05) than gilt reared pigs. Piglets receiving MR also had higher ADG during the nursery period (P<.05) than those nursing to d 19. Pigs receiving MR and nursing first litter females in 32°C benefited the most (14 d: .409 vs. 19 d: .368 kg/d). After 47 d in the nursery, 67 and 54% of the pigs provided MR in the control and heat stress environment preweaning weighed over 27.3 kg, compared to 52 and 34% of the pigs nursing the sow for 19-d, respectively. These results, and the previous abstract, show the benefit of early sow weaning in combination with MR to preserve the sow and prevent lower weaning and nursery weights under heat stress.

**Key Words:** Lactation, Heat stress, Milk replacer

**143 True ileal digestibility of amino acids in sow's milk for 17-day-old pigs.** I. Mavromichalis\*, T.M. Parr, V.M. Gabert, and D.H. Baker, *University of Illinois at Urbana-Champaign.*

The digestibility of amino acids in sow's milk consumed by young pigs is currently unknown because of difficulties associated with collecting an adequate quantity of milk, and also problems in cannulating suckling pigs. A total of 14 kg of sow's milk was collected, two soluble indigestible markers (Co-EDTA and YbCl<sub>3</sub>) were added, and the milk was fed to four pigs at 17 d of age that were fitted with a simple T-cannula at the terminal ileum. Another four cannulated pigs were offered a similar amount of a 20% DM liquid diet based on enzymatically hydrolyzed casein and lactose to assess endogenous amino acid losses. All pigs were fed about 875 g of each diet per day in 10 hourly meals from 0700 to 1700. Following 2 d of adaptation, ileal digesta were collected from 0800 to 1800 for 2 d. Diets and digesta were analyzed for amino acids using appropriate hydrolysis and preoxidation procedures. Average nitrogen true digestibility was 88%, whereas amino acid true digestibilities ranged from 84% (cystine and threonine) to 100% (methionine, histidine, and glutamic acid); the average for all amino acids was 92±4%. Based on average values, true digestibility of essential amino acids was not different from that of nonessential amino acids (P > 0.10). In whole milk, amino acids found in abundance in whey proteins (i.e., cystine, glycine, and threonine) were less (P < 0.05) digestible than amino acids predominating in casein proteins (i.e., glutamic acid, proline, and methionine). When true ileal digestible amino acid concentrations in sow's milk were expressed as ratios to digestible lysine, it appeared that threonine, tryptophan, and arginine were lower than what might be considered optimal. In conclusion, amino acids in sow's milk were highly digestible, but most of the amino acids had true ileal digestibility values significantly less than 100%.

**Key Words:** Sow's milk, Amino acid digestibility, Suckling pigs

**144 Relative bioefficacy of Biolys 60 compared to L-lysine-HCl in young pigs.** M. R. Smiricky\*<sup>1</sup>, I. Mavromichalis<sup>2</sup>, D. M. Albin<sup>1</sup>, J. E. Wubben<sup>1</sup>, M. Rademacher<sup>3</sup>, and V. M. Gabert<sup>1</sup>, <sup>1</sup>University of Illinois, Urbana, IL, <sup>2</sup>SCA Nutrition, Marion, IA, <sup>3</sup>Degussa-Huls AG, Hanau-Wolfgang, Germany.

Lysine is accepted as the first limiting amino acid in swine diets. Lysine deficient diets are generally supplemented with lysine in the form of L-lysine-HCl. Recently, a new source of lysine has been developed by Degussa-Huls called Biolys 60. Biolys 60 is a L-lysine sulfate that contains byproducts from fermentation, with a minimum lysine content of 46%. A pig growth assay was utilized to determine lysine bioavailability from Biolys 60. One hundred PIC nursery pigs with an average initial BW of 9.47 ± 1.5 kg were randomly allotted to 5 dietary treatments of 20 pigs based upon weight and gender. A corn-peanut meal diet containing 0.62% lysine was supplemented with 2 levels (.1% and .2%) of lysine as L-lysine-HCl or Biolys 60. Pigs were withdrawn from study after 3 wk. Relative bioavailability value (RBV) of Biolys 60 was determined using multiple regression slope-ratio methodology, using gain and feed efficiency as the response criteria. At the tested levels, linear responses for gain and feed efficiency were obtained. When weight gain was regressed on supplemental lysine intake, the bioavailability of Biolys 60 was 99% (P < 0.01) of L-lysine-HCl. When feed efficiency was regressed on supplemental lysine intake, the bioavailability of Biolys 60 was 97% (P < 0.01) of L-lysine-HCl. The RBV of Biolys 60 was subjected to a t-test and was determined not to be different from L-lysine-HCl, which was considered to be 100% bioavailable. These results support the conclusion that the RBV of Biolys 60 is not different from L-lysine-HCl.

**Key Words:** Pigs, Lysine, Relative Bioavailability

**145 The optimum isoleucine:lysine ratio to maximize growth performance of the early-weaned pig.** B. W. James\*, R. D. Goodband, M. D. Tokach, J. L. Nelsens, J. M. DeRouchey, and J. C. Woodworth, *Kansas State University, Manhattan.*

A 14-d growth assay was conducted to determine the optimal apparent digestible isoleucine:lysine ratio to maximize growth performance of the early-weaned pig. A total of 360 pigs (initially 5.6 kg and approximately 18 d of age, PIC C22 × 327) were blocked by weight and allotted randomly to 12 dietary treatments. Each treatment had 6 replications and

5 pigs per pen. Corn, soybean meal, spray-dried animal plasma, blood cells, fish meal, and spray-dried whey were analyzed for amino acid profiles prior to diet formulation. The 12 treatments consisted of two basal diets containing 1.00 and 1.26% apparent digestible lysine with .45 and .57% apparent digestible isoleucine, respectively. Crystalline isoleucine was added to each of the basal diets to provide concentrations of 50, 55, 60, and 65% of lysine. Two positive control diets contained 1.10 and 1.39% apparent digestible lysine. An isoleucine × lysine interaction ( $P < 0.06$ ) was observed for ADFI. Pigs fed 1.00% apparent digestible lysine had the greatest ADFI at 55% isoleucine; however, those fed 1.26% had greatest ADFI at 50% isoleucine. The greatest increase in ADG, ADFI, and G:F (quadratic,  $P < 0.01$ ) was observed as the ratio increased from 45 to 50% with further numeric improvements as the ratio increased from 50 to 55% at 1.00% apparent digestible lysine. Feeding 1.26% apparent digestible lysine improved ( $P < 0.02$ ) ADG and G:F. The positive control fed 1.39% apparent digestible lysine had greater ( $P < 0.02$ ) ADG and G:F when compared to pigs fed 1.26% apparent digestible lysine. A broken-line model predicted an isoleucine requirement of approximately 55% of lysine at 1.00% apparent digestible lysine and approximately 50% of lysine at 1.26% apparent digestible lysine to achieve optimum growth performance.

**Key Words:** Isoleucine, Lysine, Weanling pigs

**146 The tryptophan requirement of Phase I, II, and III pigs.** A. C. Guzik<sup>1</sup>\*, B. J. Kerr<sup>2</sup>, L. L. Southern<sup>1</sup>, and T. D. Bidner<sup>1</sup>, <sup>1</sup>LSU Agricultural Center, Baton Rouge, LA, <sup>2</sup>Nutri-Quest Inc., Chesterfield, MO.

Five Exp. were conducted to determine the digestible Trp (dTrp) requirement of nursery pigs. Treatments were replicated with four or five pens of five or six pigs each. Pigs were weaned at 21 (Exp. 1, 2 and 5) or 19 d (Exp. 3 and 4), and diets were fed for 8 (Exp. 1), 13 (Exp. 2 and 3), or 14 d (Exp. 4 and 5). Experiment 1 (160 pigs, initial and final BW of 8.4 and 11.4 kg) evaluated six protein sources relative to a positive control diet. The results indicated that the diet with Canadian field peas (CFP), with supplemental Trp, resulted in ADG, ADFI, and gain:feed (GF) equal to ( $P > 0.10$ ) the positive control diet. In Exp. 2 (75 pigs, initial and final BW of 13.2 and 19.2 kg) pigs were fed: 1) Trp-deficient diet (0.13% dTrp) with CFP, 2) Diet 1 + Trp (0.23% dTrp), or 3) positive control diet (0.22% dTrp). Daily gain, ADFI and GF were decreased ( $P < 0.01$ ) in pigs fed Diet 1 compared with pigs fed Diets 2 and 3, but ADG, ADFI, and GF were equal ( $P > 0.10$ ) between pigs fed Diets 2 and 3. Experiments 3 (180 pigs, initial and final BW of 5.2 and 7.3 kg), 4 (120 pigs, initial and final BW of 6.3 and 10.2 kg), and 5 (144 pigs, initial and final BW of 10.3 and 15.7 kg) were conducted to estimate the dTrp requirement of Phase I, II, and III pigs, and the diets used CFP as a primary protein source. Response variables were ADG, ADFI, GF, and plasma urea N concentrations, and data were analyzed using the broken-line model. The levels of dTrp in the diets for Exp. 3 (Phase I) were 0.14, 0.17, 0.20, 0.23, 0.26, and 0.29%. The average dTrp requirement was estimated to be 0.21% (0.24% total Trp). The levels of dTrp in the diets for Exp. 4 (Phase II) were 0.13, 0.16, 0.19, 0.22, 0.25, and 0.28%. The average dTrp requirement was estimated to be 0.20% (0.23% total Trp). The levels of dTrp in the diets for Exp. 5 (Phase III) were 0.130, 0.155, 0.180, 0.205, 0.230, and 0.255%. The average dTrp requirement was estimated to be 0.18% (0.22% total Trp). These results indicate that the dTrp requirement is 0.21, 0.20, and 0.18% for Phase I, II, and III pigs, respectively.

**Key Words:** Pig, Tryptophan, Requirement

**147 Responses of young pigs to amino acids as influenced by environmental temperature.** N. S. Ferguson\*, University of Natal, South Africa.

A series of experiments were conducted to measure the effects of dietary lysine, threonine and tryptophan concentrations and environmental temperatures on the performance of pigs grown from 13 to 25 kg live weight. In the experiments involving lysine and threonine 96 Large White X Landrace entire male pigs were used while 72 males were used in the tryptophan experiment. The experiments followed a factorial design with 4 replications per treatment. A summit-dilution technique was used to determine the six dietary treatments per amino acid, each contained the following proportion of requirements 1.10(AA1), 0.94(AA2), 0.77(AA3),

0.61(AA4), 0.45(AA5) and 0.45+synthetic amino acid (AA6), respectively. Four temperature treatments were used in the lysine and threonine experiments (18, 22, 26 and 30 °C) and three for tryptophan (20, 25 and 30 °C). To simplify comparisons between amino acid experiments the 18 and 22 °C treatments were combined and compared with the 20 °C. The response in ADFI to decreasing dietary amino acid concentrations were significantly ( $P < 0.05$ ) modified by ambient temperature. ADFI increased with decreasing amino acid contents and in some cases reached a maximum before declining. The treatment in which the pigs attained maximum ADFI depended on the temperature. For lysine and threonine ADFI was highest on AA5 at 20 °C while for tryptophan it was AA4. At 25 °C maximum ADFI was attained by pigs on AA4 for lysine and tryptophan but on AA5 for threonine. At 30 °C it was AA4 for lysine and threonine but AA3 for tryptophan. The responses in ADG to lysine and tryptophan were independent of temperature whereas threonine responses were dependent on temperature. The highest ADGs were obtained on AA1 and AA2 for all amino acids. Similarly the responses in G:F to decreasing amino acid concentrations were independent of temperature. Maximum G:F was attained on AA1. These results suggest that pigs, given a diet limiting in an amino acid, will attempt to maintain the intake of the limiting amino acid, as the concentration decreases, by increasing food intake. This compensation is dependent on the environmental temperature. Irrespective of temperature ADG and G:F were maximized on diets that were close to or exceeded the requirement of the animal.

**Key Words:** Pig, Amino acids, Temperature

**148 Amino acid digestibility of reduced concentrations of intact dietary protein fed to growing pigs.** E. R. Otto\*, P. K. Ku, and N. L. Trottier, Michigan State University, East Lansing.

Reducing dietary crude protein (CP) can reduce N excretion and ammonia emission from swine manure (Otto, 2000), but protein digestibility may be affected. The objective of this study was to test whether reducing CP of corn-soybean meal based diets (CSBM) decreases apparent (AID) and standardized (SID) ileal amino acid digestibility when crystalline amino acids (CAA) are provided to meet digestible amino acid requirements. Six crossbred barrows (53.13 ± 1.18 kg) were surgically fitted with a T-cannula at the terminal ileum and allocated to six diets in a Latin square design. Diets consisted of 15, 12, 9, and 6% CP CSBM, a 15% CP casein based, and a protein-free diet. The casein based and protein-free diets were used to determine basal endogenous AA losses (EAL). Amino acid AID and SID in the 9 and 6% diets were higher ( $P < 0.01$ ) for all indispensable amino acids (IAA) compared to the 15 and 12% diets. Amino acid digestibility in CSBM alone (AIDI and SIDI) was estimated by removing CAA in the calculations of AID and SID. Histidine, Ile, Lys, Phe, and Val AIDI and SIDI, Leu AIDI, and Met SIDI were higher ( $P < 0.01$ ) in the 9% compared to 15, 12, and 6% diets. Leucine SIDI was higher ( $P < 0.01$ ) in the 9% than the 12 and 15% diets; however, no difference was found when comparing the 6 to the 9, 12 or 15% diets. The Met AIDI was higher ( $P < 0.01$ ) in the 9% than the 6% diet. The AIDI of Met in the 12 and 15% were similar to the 6 and 9% diets. The Thr AIDI was higher ( $P < 0.01$ ) in the 9, 12, and 15% than the 6% diet. The 9% diet AIDI of Thr was higher ( $P < 0.01$ ) than the 15% diet. The Thr AIDI in the 12% was similar to the 9 and 15% diets. The Thr AIDI in the 9% was higher ( $P < 0.01$ ) than the 12 and 15% diets. The SIDI of Thr in the 9% was higher ( $P < 0.01$ ) than in the 12 and 15% diets. Threonine SIDI in the 6% was higher ( $P < 0.01$ ) than the 15% diet. The Thr SIDI in the 6% was similar to the 9 and 12% diets. Results show that AID and SID are improved in the 6 and 9% diets; AIDI and SIDI were improved when intact CP concentration was reduced from 15 to 9%. These results indicate that reducing dietary CP concentration does not reduce AID and SID when CAA are included in the diets.

**Key Words:** Reduced protein, Crystalline amino acids, Digestibility

**149 Amino acid fortified all-corn diets for late-finishing gilts.** H. J. Liu, G. F. Yi\*, J.D. Spencer, J.W. Frank, and G.L. Allee, University of Missouri-Columbia.

Seventy-eight late-finishing gilts (LFG) (85.9 kg) were used to evaluate the effects of feeding synthetic amino acid (AA) fortified all-corn diets on growth performance, carcass characteristics, nitrogen (N) retention and N excretion. Six pigs were killed at the beginning of the experiment

to analyze body composition. Pigs were randomly allotted by initial BW to one of the four dietary treatments in a complete randomized block design, with six replicate pens/trt and three pigs per pen. The control diet was a corn-soybean meal diet formulated to contain 0.59% true ileal digestible Lys (TDL) and 15.17% crude protein (CP). Diet 2 was a protein-reduced all-corn diet (9.55% CP and 0.19% TDL) fortified with synthetic L-Lys HCl, L-Thr, L-Trp, DL-Met, L-Ile, and L-Val. Diet 3 was the same as diet 2 except L-Ile was replaced by corn starch. Diet 4 was also the same as diet 2 except that L-Val was replaced with corn starch. Pigs were weighed and feed intake was recorded biweekly to an end wt of 116.8 kg. At the end of the experiment, real-time ultrasound was used to measure the 10th rib backfat (BF) and loin eye area (LEA) of all pigs. Six pigs each from trt 1 and 2 were slaughtered to measure the carcass composition, including carcass weight, carcass protein content (Nx6.25), carcass fat and moisture content, and to evaluate the effects of low-protein AA fortified all-corn diet on N retention and N excretion. No differences were found in final BW, ADG, ADFI, G:F, BF, LEA, carcass protein, fat or moisture content between pigs fed control diet and diet 2 ( $P \geq 0.05$ ). Pigs fed diet 3 (-Ile) had lower final BW than pigs fed the control diet ( $P \leq 0.05$ ). Feeding diet 4 (-Val) decreased both ADG and final BW relative to that of pigs fed on the control diet ( $P \leq 0.05$ ). There were no differences in daily N retention between trt 1 and 2 (16.79 vs 16.67 g/d), but compared to the control diet, feeding low-protein AA fortified all-corn diet (diet 2) greatly reduced daily N excretion (29.86 vs 57.74 g/d) ( $P \leq 0.05$ ). The N excretion of pigs fed diet 2 was 48.28% lower than that of pigs fed the control diet. This trial indicates that feeding LFG an all-corn AA fortified diet greatly reduce N excretion without affecting the growth performance and carcass characteristics.

**Key Words:** Pigs, Nitrogen retention, Nitrogen excretion

**150 Estimation of the threonine to lysine ratio for growing and finishing gilts.** J. W. Frank<sup>\*1</sup>, D. C. Kendall<sup>1</sup>, A. M. Gaines<sup>1</sup>, J. L. Ustry<sup>2</sup>, and G. L. Allee<sup>1</sup>, <sup>1</sup>University of Missouri-Columbia, <sup>2</sup>Heartland Lysine, Inc..

Two experiments were conducted to estimate the threonine to lysine ratio for growing and finishing gilts. In both experiments positive (PC) and negative (NC) diets containing no synthetic amino acids were fed as well as diets with true ileal digestible (TID) threonine (thr) to lysine (lys) ratios of 55, 60, 65, and 70% with TID lys being equal to that of the NC diet. For both experiments, 108 gilts (PIC 337 × C22; 3 pigs/pen and 6 pens/treatment) were used. Pigs were weighed on d 0, 14, and 28 to determine ADG, ADFI, and gain:feed ratio (G:F). In experiment 1 (initial BW = 34.1 kg), the PC diets contained .936% TID lys and .65% TID thr, whereas the NC diets contained .855% TID lys and .60% TID thr. There were no statistical differences between pigs fed PC and NC diets for ADG, ADFI, or G:F. There was a linear increase in ADG for pigs fed diets with increasing TID thr:lys ratios from 55 to 70% (linear;  $P < .02$ ). The ADG of pigs fed the diet containing 70% TID thr:lys was significantly greater than of 60% TID thr:lys (1.11 vs. 1.05 kg;  $P < .05$ ), but not different than of 65% TID thr:lys (1.11 vs. 1.07 kg, respectively;  $P > .05$ ). In addition, there tended to be a quadratic response in ADFI for the increasing TID thr:lys treatments (quadratic;  $P < .08$ ). There were no differences in G:F for any treatments. In experiment 2 (initial BW = 89.7 kg), the PC diets contained .610% TID lys and .437% TID thr, whereas the NC diets contained .561% TID lys and .410% TID thr. The NC gilts had lower ADG (.97 vs. 1.07 kg;  $P < .05$ ) and G:F (.348 vs. .372;  $P < .05$ ) than PC gilts. There was a quadratic response of increasing TID thr:lys in ADFI, 2.99, 2.73, 2.63, and 2.85 kg for 55, 60, 65, and 70%, respectively (quadratic;  $P < .02$ ). There were no differences in G:F between the PC vs. 65% or 70% TID thr:lys treatments (.372 vs. .365 or .356, respectively;  $P > .05$ ). Based on the data from these experiments the TID threonine ratio of growing and finishing gilts is not less than 65% of TID lysine.

**Key Words:** Pigs, Threonine, Lysine

**151 True digestible lysine requirements of PIC barrows over the finishing period.** R. Wei<sup>\*</sup> and D. R. Zimmerman, Iowa State University, Ames.

Three experiments were conducted to estimate the true ileal digestible lysine requirements of PIC barrows over the BW ranges of 60 to 80, 80 to 100, and 100 to 120 kg, by using plasma urea nitrogen (PUN) as

a rapid response criterion. The dietary treatments were five true digestible lysine concentrations, which were 0.50%, 0.58%, 0.66%, 0.74%, and 0.82% in Exp. 1, 0.35%, 0.43%, 0.51%, 0.59%, and 0.67% in Exp. 2, and 0.33%, 0.41%, 0.49%, 0.57%, and 0.65% in Exp. 3, respectively. Corn, soybean meal and crystalline AA were used to formulate the basal diet containing the lowest lysine concentrations, and the other four dietary lysine levels in each set were achieved by supplementation with crystalline lysineHCl. In the three experiments 20 PIC barrows with an initial BW of 45.2 kg were used in repeated Latin Square designs. Each square used five pigs of similar BW formed when the five pigs reached about 60 kg in Exp. 1, 80 kg in Exp. 2, and 100 kg in Exp. 3, respectively. Each experiment lasted for 20 d and the 20 d were divided into five 4-d dietary treatment periods. The five dietary treatments were allotted randomly within each square by using pig as the row factor and the 4-d dietary treatment period as the column factor. There were four squares in each experiment. The pigs were individually-penned and each was restricted to 2.6, 2.8, and 3.0 kg/d of experimental diet during Exp. 1, 2, and 3, respectively. Blood samples were taken at 0700 to 0800 on the last day of each 4-d period. The two-slope, broken-line analysis indicated that the true digestible lysine requirements were 19.9, 2.7, 17.4, 2.0, and 16.9, 1.5 g/d for PIC barrows at the BW ranges of 59 to 78 kg, 78 to 95 kg, and 96 to 115 kg, respectively. The corresponding 95% confidence intervals were 14.6 to 25.2, 13.5 to 21.3, and 14.0 to 19.8 g/d, respectively. Use of the Latin Square design allowed a relatively precise estimation of lysine requirements by using plasma urea as a rapid response criterion.

**Key Words:** Finishing barrows, Lysine requirement, PUN

**152 Isoleucine requirement of growing (25-40 kg) and finishing (90-105 kg) pigs.** T.M. Parr<sup>\*1</sup>, I. Mavromichalis<sup>1</sup>, B.J. Kerr<sup>2</sup>, and D.H. Baker<sup>1</sup>, <sup>1</sup>University of Illinois, Urbana, <sup>2</sup>Nutriquest, Inc., Chesterfield, MO.

A total of 310 grower (25-40 kg BW) and 210 late finisher (90-105 kg BW) PIC pigs were used in five trials to estimate the true digestible isoleucine (ILE) requirement. Basal ILE-deficient diets were based on corn and red blood cells, and grower diets contained 17.8% CP, 0.34% ILE, 1.0% lysine and 3,419 kcal ME/kg, whereas finisher diets contained 12.7%CP, 0.25% ILE, 0.73% lysine and 3,470 kcal ME/kg. Limiting amino acids other than ILE were supplemented to both diets to meet or exceed NRC (1998) recommendations. True ILE digestibility in the two ILE-deficient basal diets was done using 75 kg ileal cannulated pigs. Individual trials involved four to six pens per treatment, and five pigs per pen. Validation trials showed that the diets were severely deficient in ILE, but when fortified with surfeit ILE, weight gain and feed efficiency were not different ( $P > 0.10$ ) from that obtained with positive-control corn-soybean meal diets. Quadratic ( $P < 0.05$ ) gain and gain/feed responses occurred, with plateaus occurring at a true digestible ILE level close to 0.47% for grower pigs. Late finisher pigs were fed graded levels (0.21 to 0.29%) of digestible ILE, and quadratic ( $P < 0.05$ ) gain and gain/feed responses occurred. Optimal weight gain and gain/feed were obtained at a true digestible ILE level close to 0.28%. These empirical requirement estimates are in close agreement with the factorial ILE requirement estimates of NRC (1998).

**Key Words:** Isoleucine, Requirement, Pig

**153 The effect of fat level and source on apparent ileal amino acid digestibility and rate of passage in pigs.** D. M. Albin<sup>\*</sup>, M. R. Smiricky, J. E. Wubben, and V. M. Gabert, University of Illinois, Urbana, IL.

A study was conducted to evaluate the apparent ileal digestibilities of amino acids and rate of passage in pigs (BW = 78 kg) fed diets supplemented with either soybean or palm oil, at a concentration of 10 or 20%. A control diet with no added fat was also prepared. Diets were corn starch-soy protein concentrate based, and were formulated to contain 17% CP and 0.5% chromic oxide. Soy protein concentrate was used because of its uniform purity, while still containing notable quantities of different types of carbohydrates and fiber. A 5 × 5 Latin square design was used, but the experiment was terminated after three periods because the pigs had outgrown their cannula barrels. The pigs were allowed to adapt to each experimental diet for 5 d. This was followed by 1 d of continuous collection of ileal digesta between feedings, and a second d of continuous collection separated into six 2-h postprandial time blocks. Ytterbium chloride hexahydrate, mixed into the morning meals on d 7,

was used to determine rate of passage. Both fat level and source affected ( $P < 0.05$ ) the apparent ileal digestibilities of some amino acids. Most apparent ileal amino acid digestibilities were numerically higher in diets supplemented with soybean oil than with palm oil. The LEU digestibility was improved ( $P < 0.05$ ) from 81.0 to 84.8% with 20% soybean oil. Additionally, with increasing levels of soybean oil, SER, HIS, ARG, TYR and LEU digestibilities were linearly improved ( $P < 0.05$ ). With increasing levels of palm oil, SER, HIS, ARG and PHE digestibilities were linearly improved ( $P < 0.05$ ), while ILE and LEU digestibilities exhibited quadratic relationships ( $P < 0.05$ ). Rate of passage was unaffected ( $P > 0.05$ ) by either level or source of fat. In conclusion fat level and source affected apparent ileal amino acid digestibilities, but did not affect rate of passage.

**Key Words:** Pigs, Amino acid digestibility, Dietary fat

**154 Effect of dietary glutamine and asparagine on growth performance and nitrogen retention of broiler chicks fed low-CP diets.** K. Bregendahl\* and D.R. Zimmerman, *Iowa State University, Ames.*

Low-CP diets result in inferior growth performance and(or) carcass quality in both pigs and broiler chicks even though the dietary AA levels meet established requirements. Glutamine (Gln) and asparagine (Asn), which have been shown to be conditionally essential and to improve feed utilization in weaning pigs, are inherently low in low-CP diets. An experiment was, therefore, conducted to investigate whether dietary additions of Gln and Asn influence growth performance and nitrogen (N) retention of broiler chicks fed low-CP diets. A total of 240 day-old broiler chicks was fed a common cornsoy diet (23% CP) for 1 wk after which the chicks were allotted to one of four diets in a completely randomized design (10 chicks per pen, 6 replications). Chicks had free access to feed and water in floor pens. All diets were isoenergetic and formulated on a true ileal-digestible AA basis to meet or exceed all NRC requirements. Treatment diets consisted of a cornsoy diet (control, D1, 23.4% CP) and a low-CP diet (D2, 19.2% CP) with 1% triammonium citrate (TAC) included. D3 (19.3% CP) and D4 (18.9% CP) were formulated as D2 with Gln and Asn, respectively, replacing TAC. Feed disappearance and BW were measured weekly and feed utilization (G:F) calculated. After 2 wk on test, chicks were fasted for 24 hours and two chicks per pen were euthanized and the whole-body N content determined. Data were analyzed using GLM and least-squares treatment means were separated using Fishers protected LSD. No differences in growth performance ( $P > 0.21$ ) or N retention ( $P > 0.80$ ) were observed among chicks fed the low-CP diets (D2, D3, and D4). Contrasts (low-CP diets vs D1) were, therefore, used to separate the effects of dietary CP level. Chicks fed the low-CP diets had inferior ( $P < 0.05$ ) ADG (44.6 vs 46.8 g/d), ADFI (65.2 vs 63.2 g/d), G:F (0.68 vs 0.74), and N retention (1.16 vs 1.23 g/d) compared to chicks fed the high-CP diet. Thus, the inferior performance of chicks fed low-CP diets was probably not caused by a deficiency of Gln or Asn.

**Key Words:** Low crude protein, Glutamine, Asparagine

**155 Dietary energy during prepubertal growth and reproductive development of gilts.** J. Klindt\*, J. T. Yen, and R. K. Christenson, *USDA ARS U.S. Meat Animal Research Center, Clay Center, NE.*

The objective was to determine degree of feed restriction during development required to optimize reproductive performance and efficiency in gilts. Different patterns of growth and reproductive performance through d 30 of gestation were investigated. At 13 wk of age, 41 kg BW, 192 white crossbred gilts were penned individually and assigned to receive 7/8, 3/4, 5/8 or 1/2 of ad libitum energy intake. At 25 wk of age, gilts were moved to group pens, fed ad libitum, and an 11-wk estrous detection period initiated. Gilts were inseminated at first detected estrus (puberty). Gilts were slaughtered at 30 d of gestation. Feed restriction during development resulted in differences in BW and backfat thickness at start of the breeding period and differences in daily feed intake (ADFI) during breeding. The lightest, leanest group at the start of breeding consumed the most feed during breeding and had the fewest no. of days to puberty, followed by the heaviest, fattest group that consumed the least feed during breeding. Treatments did not differ in ovulation rate or live embryo numbers ( $P > 0.39$ ). Significant relationships between quantity of GE consumed during development and many development and reproductive performance variables were evident, e.g.,

BW and fatness at start of breeding, puberty, pregnancy, and ovulation rate. Ad libitum intake during breeding negated many effects of feed restriction during the development period. In contemporary swine production, use of managed nutritional strategies that include periods of restriction, and periods of ad libitum access to feed, may allow improvements in efficiency of pork production.

Treatment	25 wk Breeding		Days to puberty	% pubertal	Lv	Lv
	BW, kg	ADFI, kg <sup>a</sup>			Embryo /gilt <sup>a</sup>	Embryo efficiency <sup>ab</sup>
1/2 Adlib	77.8	3.76	15.3	85.4	8.9	0.0407
5/8 Adlib	92.8	3.28	24.5	79.1	8.4	0.0298
3/4 Adlib	103.7	3.19	27.9	87.5	8.6	0.0273
7/8 Adlib	112.7	3.06	22.4	85.4	7.8	0.0230
Pooled SE	0.5	0.05	1.3	—	0.4	0.0014

<sup>a</sup>All gilts assigned <sup>b</sup>Live embryos per kg feed 13 wk to 30 d gestation

**Key Words:** Gilts, Puberty, Growth

**156 Fetal and maternal responses to ad libitum feed intake during early gestation.** R.E. Musser\*, D.L. Davis, R.D. Goodband, M.D. Tokach, and J.L. Nelssen, *Kansas State University, Manhattan.*

The influence of maternal nutrition during early gestation on fetal growth and plasma metabolite concentrations was examined using 10 fourth parity sows (C 15 sows bred to line 326 boars; PIC). Sows were fed either 1.8 kg/d of a gestation diet (control, n=6) or ad libitum (7.0 kg/d; high, n=4) of feed from d 30 to 56 of gestation. At 3 h after feeding on d 56, sows were anesthetized and their reproductive tracts exposed by laparotomy. Starting from the tip of the right uterine horn, allantoic and amniotic fluid samples were collected followed by exposure of the fetal umbilical vein and harvest of fetal blood. Next, the fetus was removed, weighed, crown-rump length was measured, and a liver sample collected and frozen. Fluid and plasma samples were assayed for glycogen. Fetal pigs were homogenized and total protein, fat, ash, and moisture determined. Sows gained more weight when fed ad libitum (41.16 vs 2.12 kg;  $P < .01$ ) compared to controls. Allowing sows to consume feed ad libitum resulted in an increased plasma IGF-I and plasma urea N concentrations in the sow and fetuses. No differences ( $P > .05$ ) were found for plasma insulin or glucose in sows or fetuses. Allantoic and amniotic fluid urea N concentrations were influenced by treatment. In addition to increased fetal urea N concentration, sows fed ad libitum produced fetuses with heavier ( $P < .05$ ) livers. These responses would suggest an increased rate of deamination of amino acids. Fetuses from sows fed ad libitum had decreased ( $P < .03$ ) crown-rump length variation. Control sows exhibited a negative relationship ( $R = .43$ ;  $P < .05$ ) between the number of fetuses and average fetal weight (maternal limit). However, this relationship was not detected in ad libitum sows ( $R = .14$ ;  $P > .10$ ). Providing feed in excess of established requirements to gestating sows from d 29 to 45 increased IGF-I in maternal plasma, increased urea N in the sow and fetus, and weakened the maternal limit.

**Key Words:** Fetal, IGF-I, Sow

**157 Determining the effect of increasing L-carnitine additions on sow performance and muscle fiber development of the offspring.** R.E. Musser\*<sup>1</sup>, R.D. Goodband<sup>1</sup>, K.Q. Owen<sup>2</sup>, D.L. Davis<sup>1</sup>, M.D. Tokach<sup>1</sup>, S.S. Dritz<sup>1</sup>, and J.L. Nelssen<sup>1</sup>, <sup>1</sup>Kansas State University, Manhattan, <sup>2</sup>Lonza, Inc..

During gestation, nutritional state of the sow can influence birth weight, muscle fiber number, and growth potential of the offspring. A total of 207 sows was used in two experiments to determine the effects of L-carnitine in the gestation diet on sow performance and offspring development. Sixty-six sows (PIC line 42 sows bred to 326 boars) were fed 1.8 kg/d of feed (0.60% total lysine, 0.9% Ca, and 0.8% P) with a topdress that provided a total of 0, 50, 100, or 200 ppm added L-carnitine. In Exp. 2, 141 sows (PIC C-22 sows bred to line 56 boars) were used. Sows were fed 1.8 kg/d of feed (0.65% total lysine, 0.83% Ca, and 0.76% P) and a topdress as in Exp. 1. The experiments were combined for analysis of production criteria, but muscle fiber data was analyzed separately due to differences in pig age at sampling. Cubic differences were observed ( $P < .10$ ) in subsequent number of pigs born per litter (10.7, 11.5, 10.0, or 10.9) for sows fed 0, 50, 100, or 200 ppm of L-carnitine.

Estimates were made from a sub-population for total number of muscle fibers in the semitendinosus muscle. In Exp. 1, 21 d old pigs (n = 22) from sows fed 50 ppm L-carnitine tended to have larger (P < .20) cross-sectional area of the semitendinosus muscle than pigs from control sows. Analysis of newborn pigs (n = 97) in Exp. 2 indicated a larger (P < .01) cross-sectional area and more (P < .10) total muscle fibers in the semitendinosus muscle for pigs from sows fed 50 ppm L-carnitine compared to control sows. This research indicates that sows fed added L-carnitine, possibly due to differences in maternal energy status, could produce offspring with greater muscle fiber diameter and total number of muscle fibers.

	0 ppm	50 ppm	100 ppm	200 ppm
Exp. 1, 21 d-old pigs				
Fibers / mm <sup>2</sup>	1,222	1,243	1,428	1,387
Area, mm <sup>2</sup>	295	381	244	322
Total muscle fibers	356,712	456,208	375,866	430,089
Exp. 2, 1 d-old pigs				
Fibers / mm <sup>2</sup>	3,458	3,481	3,484	3,635
Area, mm <sup>2</sup>	144	156	148	129
Total muscle fibers	492,376	524,269	493,318	460,643

**Key Words:** L-carnitine, Sow, Muscle fiber

**158 Supplemental dietary phytase improves bioavailabilities of organic phosphorus and other nutrients in corn-soybean diets for sows.** S.K. Baidoo<sup>\*1</sup>, Q.M. Yang<sup>1</sup>, R.D. Walker<sup>1</sup>, and J.L. Boychuk<sup>2</sup>, <sup>1</sup>SROC, *University of Minnesota, Waseca*, <sup>2</sup>BASF (Canada).

Thirty multiparous sows were used to investigate the effects of two dietary inorganic phosphorus regimens on P utilization and performance using corn-soybean meal based supplemented with microbial phytase (Natuphos, BASF) during gestation and lactation. The control diet contained 0.74% P without added phytase and the treatment diet contained 0.54% with added phytase at 500 FTU/kg. Chromic oxide (0.2%) was added to the diets as a marker to determine nutrient digestibility. Blood samples were collected from anterior vena cava at farrowing and weaning to determine inorganic phosphorus in the serum. The digestibility of total phosphorus, organic phosphorus, crude protein and organic matter in the diet with added phytase were, 72.9%, 60.5%, 72.8% and 83.0%, respectively, which was higher (P<.01) than 58.9%, 28.3%, 61.6% and 77.2% in the control diet. Total phosphorus content in the feces of the sows fed diets with phytase decreased by 27.1% compared with the feces of sows fed the control diet (P<.01). The serum inorganic phosphorus (IP) concentrations at farrowing (107.1 and 103.1 mg/L for control and phytase supplemented diets, respectively) were higher (P<.05) than the serum levels of IP at weaning (89.8 and 90.6 mg/l for the control and phytase supplemented diets respectively). The lactation performance of the sows, such as body weight and backfat changes, litter size and litter weight at weaning were not influenced by a reduction in IP with addition of phytase.

**Key Words:** Sows, Phosphorus, Phytase

**159 Replacement value of field peas for soybean meal in sow lactation diets.** D.G. Landblom<sup>\*1</sup>, W.W. Poland<sup>1</sup>, R.L. Harrold<sup>2</sup>, and K. Miller<sup>2</sup>, <sup>1</sup>Dickinson Research Extension Center, <sup>2</sup>North Dakota State University, Fargo.

One hundred ninety-two lactating sows were used to evaluate the effect on sow and litter performance, sow body condition change, milk composition, and days to first estrous when field peas (*Pisum sativum*) replaced 10, 20, and 30% of the dietary soybean meal. Parity and lactation days for the four treatments were 3.10, 3.27, 2.96, and 2.90, and 19.2, 18.7, 19.0, and 19.2 days, respectively. Daily feed intake and calculated metabolizable energy (ME) consumption of 19.3, 20.9, 19.4, and 20.2 Mcal/day were similar across treatments suggesting field pea replacements for soybean meal up to 30% of the diet did not compromise diet acceptance or dietary energy consumption. Sow performance was unaffected by the level of pea grain in the lactation diet, and, as such, lactation sow weight change from farrowing to weaning, and days to first estrous did not differ. Mid-lactation milk composition on d 14 to include milk solids, protein, and fat, and body fat depth change did not differ between the corn/soy control and test diets containing 10 to 30% peas.

Litter performance favored pigs nursing sows receiving the 10% pea test diet. Sows receiving the 10% pea diet weaned more (P<.05), and heavier (P<.05) pigs, and had a numerically greater, but non-significant, increase in pig survival than the corn/soy control and other test diets containing 20 and 30% peas. Results suggest pork producers can effectively use up to 30% field peas as a dietary protein and energy substitute for soybean meal in sow lactation diets without compromising sow performance, milk composition, return to estrous, litter performance, and litter survival rate. The decision for replacing up to 30% of the soybean meal in sow lactation diets with peas would be based on the comparative per unit cost of protein and energy.

**Key Words:** Sows, Field peas, Lactation

**160 Variation in international soybean meal quality.** C. M. Grieshop<sup>\*</sup>, A. B. Batal, D. H. Baker, C. M. Parsons, and G. C. Fahey, Jr., *University of Illinois, Urbana*.

Soybean meal (SBM) is a key protein source in monogastric diets worldwide. The nutritional quality of SBM is determined by soybean (SB) cultivar usage, environmental factors, and processing conditions used to prepare the SBM. High, moderate, and low quality SBMs were collected from processors in Argentina, Brazil, China, India, and the United States. In addition a common variety SB sample was collected from each country and converted to SBM under uniform conditions in the U.S. Soybean meal crude protein concentration (% of DM) varied from 59.5 in high quality India SBM to 48.8 in low quality Chinese SBM. Crude protein concentration also varied considerably (47.4 to 58.5% of DM) in SBM produced in the U.S. from international SBs. Argentinean low quality SBM contained the highest concentration of lipid (5.9% of DM) while low quality U.S. SBM contained only (3.2% of DM). Lipid concentration of SBMs produced in the U.S. from international SB ranged from 2.9 to 5.6% of DM. Total dietary fiber concentration was highest in Argentinean moderate quality SBM and U.S. SB processed under uniform conditions. Protein quality of SBM samples was determined using the protein efficiency ratio (PER) assay. Eight-day-old male chicks were fed 10% crude protein diets (as-fed basis), with the only source of protein being the SBM of interest. Chicks fed the high quality U.S. SBM gained faster (P<.05) and had a numerically higher PER (4.1 g wt. gain/g CP intake) than chicks fed any other SBM diet. The results of this study indicate that the nutrient composition and protein quality of soybeans and SBM vary depending on country of origin.

**Key Words:** Soybean meal, International, Chick PER

**161 Use of dry extruded-expelled soybean meal for swine diets.** M. J. Webster<sup>1</sup>, J. C. Woodworth<sup>\*1</sup>, M. D. Tokach<sup>1</sup>, R. D. Goodband<sup>1</sup>, J. L. Nelssen<sup>1</sup>, S. S. Dritz<sup>1</sup>, and N. W. Said<sup>2</sup>, <sup>1</sup>Kansas State University, Manhattan, <sup>2</sup>Insta-Pro International, Des Moines, IA.

Two experiments were conducted to determine the effects of different extruder temperatures and meal manufacturers on the feeding value of dry extruded-expelled soybean meal (EESoy) for swine. In Exp. 1, pigs (n=330, 13.2 kg BW) were fed a control diet containing solvent-extracted soybean meal (SBM) or one of five diets containing EESoy extruded at 143.3, 148.9, 154.4, 160.0 or 165.6 °C. All diets were formulated on an equal digestible lysine: ME ratio. From d 0 to 20, ADG was 570, 525, 528, 553, 535, 551 g/d and G/F was 0.61, 0.56, 0.59, 0.60, 0.57, 0.59 for pigs fed either SBM or EESoy with processing temperatures of 143.3 through 165.6 °C, respectively. No differences were observed in ADG or ADFI (P>0.32). However, G/F improved (quadratic, P<0.01) with increasing processing temperature and the greatest improvement was observed at 154.4 °C. In Exp. 2, pigs (n=150, 9.9 kg BW) were used to determine the variation in EESoy supplied from different manufacturers. Pigs were randomly allotted to one of five diets consisting of a negative control diet containing SBM and no added fat (1.1% total lys), three diets containing EESoy from one of three different manufacturers (1.14% total lys), and a positive control diet containing SBM and 3.29% soy oil (1.14% total lys). All diets were formulated to the same lysine:ME ratio (3.31 g/Mcal). Overall, ADG was not influenced by treatment; however, ADFI was greater (P < .005) and G/F was lower (P < .007) for the negative control compared to all other treatments. These experiments suggest that there were no differences in the quality



of EESoy from the commercial manufacturers tested and that processing temperature should be 154.4 °C.

**Key Words:** Nursery pig, Soybean meal, Processing

**162 Grower-finisher growth performance and carcass characteristics including attempts to detect transgenic plant DNA and protein in muscle from pigs fed genetically modified "Bt" corn.** T. E. Weber\* and B. T. Richert, *Purdue University, West Lafayette, IN.*

A feeding experiment was conducted to demonstrate similar growth performance and carcass quality in grow-finish pigs fed diets containing "Bt" corn as compared to "non-Bt" corn. Bt corn resists the European Corn Borer by expressing the Cry1Ab selective insecticidal protein from *Bacillus thuringiensis*. Pigs (n=180; DeKalb EB x 45; 30 5.2 kg BW) were randomly assigned to one of three dietary treatments: diets containing 1) Bt corn (Bt); 2) the near isogenic control to the Bt corn (NIC); or 3) commingled conventional, non-genetically modified, corn hybrids (CC). The experimental diets were fed in four phases, and were formulated to contain equal percentages of each corn source within each phase. Pig growth rates were similar between corn sources ( $P > .10$ ) at all time points. Barrows had greater overall ADG, ADFI, and lower feed efficiency (G:F) than gilts ( $P < .01$ ). Pigs were harvested at 121 kg and carcass data collected. Pigs fed CC had greater HCW and dressing percentage ( $P < .05$ ) than pigs fed NIC or Bt. Pigs fed NIC had greater 10th rib fat depth than either Bt or CC fed pigs ( $P < .05$ ). Pigs fed the NIC corn had lower predicted percent lean than CC fed pigs ( $P < .05$ ), but similar percent lean to Bt fed pigs. Pigs fed NIC had greater visible loin marbling than CC fed pigs ( $P < .05$ ) and barrows had greater visible loin marbling than gilts ( $P < .05$ ). Gilts had greater loin eye area and less backfat at the 10th and last rib ( $P < .05$ ) and greater predicted percent lean than barrows ( $P < .05$ ). DNA was extracted from loins of 12 pigs fed Bt and 12 pigs fed NIC diets. Southern blot analysis of PCR products was performed to screen for the presence of specific fragments of the cry1Ab and the endogenous corn protein Shrunken-2 (sh-2) genes. None of the extracted DNA samples were positive for cry1Ab or sh-2 genes. Also, using a competitive immunoassay cry1Ab protein was not detected in the extracts of loin samples from pigs fed Bt corn. Results indicate pig growth performance and carcass characteristics are similar in pigs fed diets containing "Bt" or "non-Bt" corn. Furthermore, no evidence of passage of the transgene from the corn to the pigs tissue was found.

**Key Words:** Bt corn, Pigs, Growth

**163 Comparison of two methods to determine DE content of barley for grower pigs.** M.N. Casano\*<sup>1,2</sup> and R.T. Zijlstra<sup>1</sup>, <sup>1</sup>*Prairie Swine Centre Inc.*, <sup>2</sup>*University of Saskatchewan, Saskatoon, Canada.*

The DE content of cereal grains is measured generally in a protein-deficient diet to which pigs have restricted access. The method does not reflect practical conditions and prevents measurement of voluntary feed intake. The DE content of five barley samples was measured using two methods, in a 2x5 factorial arrangement, in 6 blocks of 10 pigs (202.6kg) penned individually. The restricted-standard diet (RSD)-method consisted of a 95.5%-barley mash-diet (2950 kcal DE/kg, 10.1% CP, 0.81 g d Lys/Mcal DE) fed at 3xDE Maintenance requirement for 12 d after a 4-d acclimation. The ad lib-modified diet (AMD)-method consisted of a barley (75%), soybean meal (18%), and canola oil (2%) mash-diet (3165 kcal DE/kg, 16.5% CP, 2.24 g d Lys/Mcal DE) fed with free access for 16 d. Feces were collected on the final 3 d. The ADFI and daily DE intake were higher ( $P < 0.05$ ) in AMD- vs RSD-pigs, resulting in a 260% increase in ADG (851 vs 239 g/d;  $P < 0.05$ ). Likewise, apparent energy digestibility of diets and calculated barley DE were higher ( $P < 0.05$ ) in AMD- (75.1%, 3066 kcal/kg DM) vs RSD-pigs (74.1%, 2999 kcal/kg DM). For DE content, method and barley sample interacted ( $P = 0.12$ ), indicating that barley samples were ranked differently for each method. The DE intake of RSD-pigs was correlated to ADF ( $r = -0.92$ ), NDF ( $r = -0.91$ ), density ( $r = 0.84$ ), and water-holding capacity ( $r = -0.78$ ). In AMD-pigs, ADFI ranged from 1.36 to 1.51 kg/d for d 1 to 8, and from 1.68 to 1.78 kg/d overall, but DE intake was similar ( $P > 0.10$ ) among barley samples. The DE intake of AMD-pigs was correlated to barley DE ( $r = -0.82$ ), particle size ( $r = -0.73$ ), ADF ( $r = -0.66$ ), and NDF ( $r = -0.59$ ). Fiber predicted barley DE content in the RSD- (ADF,  $R^2 = 0.61$ ; NDF,  $R^2 = 0.58$ ;  $P < 0.05$ ) and AMD-method (NDF,  $R^2 = 0.66$ ; ADF,  $R^2 = 0.62$ ;

$P < 0.05$ ). In summary, an increase in fiber was related to a reduction in DE content of barley and DE intake. Method to analyze DE content affected the measured barley DE content, and voluntary feed intake might differ among barley samples.

**Key Words:** Pig, Barley, Digestible energy

**164 A comparison between feeding plasma and peptide proteins on nursery pig growth performance and intestinal health.** C. A. Boren\*<sup>1</sup>, M. S. Carlson<sup>1</sup>, T. L. Veum<sup>1</sup>, J. R. Turk<sup>1</sup>, and G. W. Tibbetts<sup>2</sup>, <sup>1</sup>*University of Missouri-Columbia*, <sup>2</sup>*Alltech Biotechnology, Inc., Nicholasville, KY.*

Two 28-d studies were conducted to evaluate the effectiveness of peptide protein compared to plasma protein fed during the nursery period with and without carbadox on growth performance and intestinal morphology. In Exp.1, 144 pigs (19 2 d of age; 5.72 kg) were weaned and allotted to 3 dietary treatments (containing 50g/ton carbadox) utilizing 8 replications of 6 pigs/pen. In Exp.2, 84 pigs (20 2 d of age; 6.17 kg) were weaned and allotted to 3 dietary treatments (without carbadox) with 7 replications of 4 pigs/pen. The basal Phase 1 (d 1 14) and Phase 2 (d 15 28) diets contained no animal plasma or blood products. Two more diets were made by the addition of either 5 % (Phase 1) or 2.5 % (Phase 2) of animal plasma or peptide proteins (Ultimate Protein 1672). In Exp.1, there was a trend ( $P = .08$ ) for pigs fed plasma protein to have the highest overall ADG with pigs fed peptide protein being intermediate, and pigs fed the control diet having the lowest ADG (392, 378, and 359 g/d, respectively). In Exp.2, pigs fed either plasma or peptide proteins had the highest overall ADG ( $P < .004$ ) when compared to pigs fed the control diet (395, 385, 338 g/d, respectively). In both Exp. 1 and 2, feed intake was improved ( $P < .05$ ) by the addition of either plasma protein or peptide protein during Phase 1, Phase 2 and overall. Duodenal morphology was not different on d 7 or d 14 of Exp. 1 and d 7 or d 28 of Exp.2 ( $P > .05$ ). On d 28 of Exp. 1, pigs fed either peptide protein or animal plasma had reduced crypt depth and total wall thickness ( $P < .04$ ). Also, on d 28, pigs fed the peptide protein diet had decreased ( $P = .04$ ) villous width and a trend for thinner ( $P = .09$ ) lamina propria area compared to pigs fed the control or animal plasma diets. In conclusion, feeding either animal plasma or peptide proteins with or without carbadox post-weaning improved overall pig performance and to a lesser degree intestinal health.

**Key Words:** Nursery pigs, Peptide proteins, Duodenum

**165 Effects of gamma ray and electron beam irradiation levels in spray-dried blood meal on nursery pig performance.** J.M. DeRouchey\*, J.L. Nelssen, M.D. Tokach, R.D. Goodband, S.S. Dritz, J.C. Woodworth, M.J. Webster, B.J. James, and D.E. Real, *Kansas State University, Manhattan.*

Recent research conducted at our experiment station has shown improved growth performance of nursery pigs that have consumed dried blood products that have undergone irradiation treatment. However, different types and dosage levels of irradiation have not been thoroughly investigated. Thus, 300 weanling pigs (initially 10.7 kg and  $17 \pm 6$  d of age) were used in a 19-d growth assay to determine the effects of increasing levels (2.5, 5.0, 10.0, or 20.0 kGy) of gamma ray or electron beam irradiation of spray-dried blood meal (BM) on nursery pig performance. All pigs were fed the same pelleted SEW and Transition diets to 4 d post-weaning. At d 4, pigs were switched to experimental diets, which included a control diet with no added BM, a diet with 5% regular BM or 5% BM with irradiation treatment. Irradiation treatments included BM subjected to either gamma ray (cobalt-60 source) or electron beam irradiation at increasing dosage levels (2.5, 5.0, 10.0 or 20.0 kGy). All BM used in this experiment was from the same lot. Treatment diets were fed in meal form and formulated to contain 1.40% lysine, 0.90 Ca, and 0.54 available P. Irradiation of BM proved effective in the reduction of aerobic bacteria, *E. coli*, mold, and yeast concentrations. Overall, (d 5 to 19 post-weaning), the inclusion of irradiated BM tended ( $P < .09$ ) to improve feed efficiency (G/F). However, ADG (318 vs 343 g) and ADFI (459 vs 465 g) were similar ( $P < .26$ ) when comparing the nonirradiated versus the irradiated BM treatments. In addition, the inclusion of BM did not improve growth performance over the control diet without BM. These results indicate that irradiation is an effective technology to reduce or eliminate bacteria, molds, and yeast in BM. Increasing the dosage level above 2.5 kGy, regardless of source, did not

affect growth performance. Also, both electron beam and gamma ray irradiation demonstrated similar results in performance.

**Key Words:** Pig, Blood meal, Irradiation

**166 Effects of irradiation processing of specialty protein products on nursery pig performance.** J.M. DeRouchey\*, M.D. Tokach, J.L. Nelssen, R.D. Goodband, S.S. Dritz, J.C. Woodworth, M.J. Webster, B.W. James, and D.E. Real, *Kansas State University, Manhattan.*

Recent research from Kansas State University has shown improved growth performance of nursery pigs fed diets containing irradiated animal plasma (AP) or blood meal compared to nonirradiated forms. In this 14-d growth assay, 300 weanling pigs (initially 6.1 kg and  $20 \pm 2$  d) were used to determine the effects of irradiation processing of other specialty protein products. All diets were fed in pelleted form and formulated to contain 1.50% lysine, 0.90 Ca, 0.80 P, 0.46 Na, and 0.57 Cl. In addition, 2.50% fishmeal and 0.15% L-Lysine HCl were added to all diets with other crystalline amino acids included (if necessary) to maintain similar ratios of amino acids related to lysine. Treatments included a control diet or the control with 5% AP (American Protein Corp., AP 920); animal plasma, dried egg product, animal serum, serum albumin, and serum globulin combination (DuCoa L.P., ProtiOne<sup>TM</sup>); dried porcine digest (Nutra-Flo Protein Products, DPS 30); liquefied and spray-dried beef muscle (Esteem Products Inc., Peptide Plus<sup>TM</sup>); and spray-dried whole egg (California Spray Dry). All specialty products were either fed irradiated or as-is, and originated from the same lot for each source. Since all specialty products were included in the diet at a fixed amount, and not on a nutrient profile basis, direct comparisons between these products were not made, nor was it an objective of this experiment. Overall, irradiation of AP and Peptide Plus<sup>TM</sup> resulted in increased ( $P < .05$ ) ADG compared to pigs fed the nonirradiated form. Irradiation of Peptide Plus<sup>TM</sup> also improved ( $P < .05$ ) G/F compared to its nonirradiated form. The other specialty protein sources were not influenced by irradiation. Bacteria levels varied widely, but irradiation decreased bacteria for every source. Because the two protein sources that responded to irradiation had the highest (AP) and the lowest (Peptide Plus<sup>TM</sup>) bacteria level, the growth improvements from irradiation do not appear to be solely from a decrease in bacteria.

**Key Words:** Pig, Protein source, Irradiation

**167 Ileal mucin output in growing pigs fed semipurified diets with different protein sources.** D. M. Albin\*, M. R. Smiricky, J. E. Wubben, and V. M. Gabert, *University of Illinois, Urbana.*

Crude mucin was isolated from ileal digesta collected from ileally-cannulated growing pigs (BW = 35 kg) fed semipurified diets. Corn starch-based diets were fed, and contained soybean meal (SBM), soy protein concentrate (SPC) or casein as the sole protein source. The diets containing SBM and SPC were formulated to contain 17% CP. A low-protein casein diet was used to estimate endogenous secretions. Chromic oxide was included in all diets at 0.5%. Feed intake was equalized in each period. After adapting to a new diet for 5 d, ileal digesta were collected continuously for 12 h on d 6 and 7. For each diet, crude mucin was isolated from ileal digesta collected from four pigs. The crude mucin isolation procedure obtained the water soluble-ethanol precipitable fraction of ileal digesta. This procedure has also been shown to isolate nonmucin protein and carbohydrates. However, contaminating substances from the diet were present in relatively low quantities, and these substances have been shown to be highly digestible at the terminal ileum. Also, THR, SER and PRO are present in high quantities in purified mucin, and the crude mucin isolate contained significant quantities of these amino acids (approximately 25%). Crude mucin contributed significant quantities of amino acids (from 5 to 46%) to the total amino acids lost at the ileum. The type of diet fed affected ( $P < 0.05$ ) crude mucin output. The use of a semipurified diet to estimate endogenous secretions of amino acids underestimated the contribution from mucin. Feeding diets with SPC, and especially SBM, increased ( $P < 0.05$ ) crude mucin output. When correcting for endogenous losses from mucin only, apparent ileal digestibility coefficients were significantly increased ( $P < 0.05$ ). The apparent THR digestibility for the diet containing SBM was

increased from 70.8 to 81.1% when corrected for mucin only. In conclusion less-refined protein sources increased ileal crude mucin output, which is an important source of endogenous amino acid losses, in pigs.

**Key Words:** Pigs, Amino acids, Mucin

**168 True digestible lysine requirements of PIC barrows over the growing-finishing period.** R. Wei\* and D. R. Zimmerman, *Iowa State University, Ames.*

Five experiments were conducted to estimate the true ileal digestible lysine requirements of PIC barrows at approximately 30, 50, 70, 90, and 110 kg of BW, respectively, by using plasma urea nitrogen (PUN) as a rapid response criterion. Pigs were individually-penned and had free access to feed and water. The dietary treatments were a set of five true digestible lysine concentrations, which were 0.732%, 0.807%, 0.882%, 0.957%, and 1.032% in Exp. 1, 0.527%, 0.602%, 0.667%, 0.752%, and 0.827% in Exp. 2, 0.430%, 0.510%, 0.590%, 0.670%, and 0.750% in Exp. 3, 0.354%, 0.434%, 0.514%, 0.594%, and 0.674% in Exp. 4, and 0.313%, 0.393%, 0.473%, 0.553%, and 0.633% in Exp. 5, respectively. Corn, wheat, soybean meal and crystalline AA were used to formulate the basal diets containing the lowest lysine levels, and the other four lysine levels in each set were achieved by lysineHCl supplementation. Exp. 1 and 2 used 20 PIC barrows with an initial BW of 19.1 kg. The pigs were blocked on litter and initial BW to form four blocks in randomized complete block designs with five dietary treatments. In Exp. 3, 4 and 5, 20 PIC barrows with an initial BW of 59.0 kg were used in completely randomized designs with five dietary treatments. The dietary treatments started when pigs reached about 30 kg in Exp. 1, 50 kg in Exp. 2, 70 kg in Exp. 3, 90 kg in Exp. 4 and 110 kg in Exp. 5, respectively. Each experiment lasted for 5 d and the pigs were bled at 0700 to 0800 for the last 2 d of the period. Pretreatment PUN was used as a covariate to correct the PUN variation not related to lysine adequacy. By fitting the corrected PUN responses to dietary lysine concentrations into a two-slope, broken-line regression model, the estimated true digestible lysine requirements were 16.5 0.2, 17.8 0.8, 20.2 1.2, 16.7 0.8, and 14.4 6.7 g/d for PIC barrows at 33, 52, 72, 93, and 113 kg of BW, respectively. Because of the large variance of PUN concentration and the small sample size, the confidence in the lysine requirement estimates was low.

**Key Words:** Growing-finishing barrows, Lysine requirement, PUN

**169 Optimum threonine:lysine ratio for pigs in the 90 to 120 kg phase.** M.E. Johnston\*<sup>1</sup>, R.D. Boyd<sup>1</sup>, C.E. Fralick<sup>2</sup>, and J.L. Usry<sup>3</sup>, <sup>1</sup>PIC USA Inc., Franklin, KY, <sup>2</sup>Swine-Tek Research and Consulting, Van Wert, OH, <sup>3</sup>Heartland Lysine Inc., Chicago, IL.

The objective was to determine the optimum threonine:lysine ratio for pigs fed from 92.0 to 115.8 kg BW using corn-soy diets. PIC337 x C22 castrates and gilts (45 pens, 8 to 10 pigs/pen) were sorted by weight and randomly allotted to one of nine diets (92.0±1.0 kg, 44 pigs/diet). Positive (1) and negative (2) control diets contained corn and soy as the only amino acid sources (0.61 and 0.56% true ileal digestible lysine (TID Lys), respectively). Diet 3 contained 0.225% added L-lysine (0.56% TID Lys). Diet 4 contained 0.34% added L-lysine (0.56% TID Lys), 0.02% L-tryptophan, 0.045% L-isoleucine, and 0.045% L-valine. Diets 5, 6, 7, and 8 were the same as diet 4 except corn was replaced by L-threonine at rates of 0.03, 0.06, 0.095, and 0.125%, respectively. Diet 9 contained 0.34% added L-lysine and 0.095% added L-threonine. Feed intake was unaffected ( $P > .60$ ) by dietary treatment. There was a numerical decrease ( $P = .13$ ) in feed conversion (GF) when pigs were fed diet 2 vs diet 1 suggesting that TID Lys was limiting in diet 2. The addition of 0.225% L-lysine (diet 3) resulted in further decline ( $P = .20$ ) in GF compared to the negative control diet (0.30 vs 0.31). The addition of L-tryptophan and L-isoleucine (diet 4) did not bring ( $P < .01$ ) ADG or GF to the same level as in diet 2 (0.78 vs 0.91 kg/d and 0.26 vs 0.31, respectively). The addition of L-threonine to the diet in increasing amounts (diets 5, 6, 7, 8) resulted in a linear improvement ( $P < .01$ ) in ADG and GF compared to diet 4. Daily gain and GF (0.89 kg/d and 0.30) were maximized for pigs fed diet 7 which had a TID Thr:Lys ratio=68%. Removing added L-tryptophan, L-isoleucine, and L-valine (diet 9) and leaving 0.34% added L-lysine and 0.095% added L-threonine in the diet, caused ADG and GF to decrease (0.83 kg/d and 0.28,  $P < .05$ ) compared to pigs fed diet 7 suggesting L-tryptophan, L-isoleucine, and/or L-valine were limiting. Based on these data, the optimum TID Thr:Lys ratio for pigs in the 90 to 120 kg phase is 68%.

**Key Words:** Pigs, Lysine, Threonine

**170 Plasma urea concentrations of pigs on commercial operations.** R. L. Fischer\*, P. S. Miller, and A. J. Lewis, *University of Nebraska, Lincoln.*

Research was conducted on commercial swine operations to determine whether plasma urea concentrations could be used as an indicator of the protein requirement of growing-finishing pigs. The experiment consisted of a 30-question survey and an on-farm visit to collect blood and feed samples. The survey included questions about genetics, nutrition, housing, and health. During the farm visit, blood samples were collected from 10 barrows and 10 gilts within each growth phase (nursery, growing, and finishing). A feed sample was collected for each group of pigs sampled. The feed samples were analyzed for CP concentration and plasma samples were analyzed for urea concentration. Results indicated that when plasma urea concentrations were analyzed across all phases of production, barrows had greater ( $P < 0.05$ ) plasma urea concentrations than gilts. Plasma urea concentrations varied among the different phases of production ( $P < 0.01$ ), with nursery pigs having the lowest plasma urea concentrations, followed by growing and finishing pigs, respectively. An increase in dietary CP resulted in an increase ( $P < 0.01$ ) in plasma urea of barrows and gilts in all phases of production. The comparison of dietary CP concentrations and age of the pigs at the time of blood collection indicated that the majority of the diets were overformulated for CP. This excess dietary CP concentration was a result of the difference in the presumed genetic potential ( $> 325$  g/d) and the actual (275 g/d) fat-free lean gain of the pigs. The difference in the perceived and actual fat-free lean gain was approximately 15%, which would account for the overformulation of dietary CP concentration. The effects of sex, CP, and phase of production on plasma urea concentrations in pigs raised on commercial operations were similar to those observed in a research setting. These results suggest that, within an individual swine operation, plasma urea is a useful indicator of the protein requirement of growing-finishing pigs.

**Key Words:** Pigs, Plasma urea concentration, Dietary crude protein

**171 The molecular form of dietary protein influences growth performance of broiler chicks.** K. Bregendahl\* and D.R. Zimmerman, *Iowa State University, Ames.*

Low-CP diets result in inferior growth performance in both pigs and broiler chicks even though the dietary AA levels meet established requirements. Essential and non-essential crystalline AA (EAA and NEAA, respectively) have been added in various amounts and combinations to low-CP diets in attempts to overcome the growth retardation, albeit to no avail. An experiment was conducted to investigate whether the molecular form of dietary protein influences growth performance of broiler chicks. A total of 240 day-old broiler chicks was fed a common cornsoy diet (23% CP) for 1 wk, after which the chicks were allotted to one of four treatment diets in a completely randomized design (10 chicks per pen, 6 replications). Chicks had free access to feed and water in floor pens and were fed the isoenergetic treatment diets for 2 wk. Treatment diets consisted of a cornsoy diet (D1, 23% CP) and a similar diet, D2, where some of the intact protein was replaced with crystalline EAA and NEAA on a true ileal-digestible basis. The contents of *all* EAA and *all* NEAA in D2 were identical to those in D1, differing only in the molecular form of the dietary protein: All protein in D1 was from intact protein, whereas about half the protein in D2 was from crystalline AA. D3 (17% CP) was similar to D2, but with no crystalline NEAA added. Feed disappearance and BW were measured weekly and feed utilization (G:F) calculated. Data were analyzed using GLM and least-squares treatment means were separated using Fishers protected LSD. All diets resulted in different growth performance responses ( $P < 0.001$ ) with ADG of 42.4, 36.6, and 29.6 g/d; ADFI of 58.4, 53.6, and 51.0 g/d; and G:F of 0.73, 0.68, and 0.58 for D1, D2, and D3, respectively. Differences in feed utilization between chicks fed D1 and D2 indicated that the molecular form of the dietary protein (i.e., intact protein vs free AA) influenced the utilization of the diets. Omission of crystalline NEAA affected growth performance, indicating that nitrogen may be limiting in low-CP diets or that some NEAA may be conditionally essential.

**Key Words:** Low crude protein, Growth performance, Intact protein

**172 Relative potential for lysine oxidation in tissues of neonatal pigs.** N. J. Benevenga\*, L. G. Haas, and T. D. Crenshaw, *University of Wisconsin-Madison.*

A description of tissue and subcellular distribution of the potential for lysine catabolism in pigs is not readily available. Earlier work in rats (J. Nutr. 106:1089-1096, 1976) showed the enzymes for lysine catabolism are found in liver, kidney and pancreas. In rat liver preparations the first two enzymes for lysine degradation are housed exclusively in the mitochondrion matrix, consistent with the potential for transport control of lysine catabolism (J. Nutr. 124:1215-1221, 1994). In the current preliminary work, an incubation system was used to measure conversion of U-<sup>14</sup>C-L-lysine to <sup>14</sup>CO<sub>2</sub> in pig liver, kidney and heart "cytosol" and "mitochondrial" preparations. Incubation conditions were pH 7.2, 10 mmol/L L-lysine; 1 mmol/L alpha-ketoglutarate; 1 mmol/L NAD. Production of CO<sub>2</sub> from liver mitochondria was linear up to 90 min and with enzyme up to 1.3 times that normally used. Comparison of the potential for lysine oxidation in the 24,000 x g supernatant (cytosol) and a mitochondrial preparation (24,000 x g pellet) from liver, heart and kidney indicated all of the activity was associated with "mitochondria", consistent with the subcellular location of lysine catabolism in mitochondria, as documented in rats. Calculation of tissue enzyme activity distribution was based on recovery of the mitochondrial matrix enzyme, ornithine aminotransferase, in homogenate and mitochondrial fractions. Kidney and heart specific activity (nmoles CO<sub>2</sub>/(h x g) for lysine oxidation were over 128% of liver activity. The distribution of activity in the pig was calculated based on total organ mass and specific activity. Relative to liver, kidney and heart were 22% and 28% of that in liver or account for 15% and 19% of total body potential. Lysine is catabolized in at least three organs in the neonatal pig and is apparently restricted to the mitochondria, as it is in rats.

**Key Words:** Pig, Lysine, Mitochondria

**173 Plasma iron, latent and total iron binding capacity and percent saturation of newborn and seven day old pigs.** N. J. Benevenga\*, L. L. Pope, and T. D. Crenshaw, *University of Wisconsin-Madison.*

Earlier (J. Anim. Sci. 70:(Suppl. 1) 73, 1992) we reported that in newborn piglets plasma iron concentration was about 75 g/dL and the latent iron binding capacity measured in plasma was 0 g/100 mL suggesting that plasma transferrin approached 100% saturation. Over the next 5 d total iron binding capacity increased from 75 to 400 g/dL and percent saturation (%SAT) fell to 25%, consistent with adult values. In the current experiment piglets were given 100 mg iron as iron dextran IM on d 1 after the initial blood sample was taken. Plasma iron and latent and total iron binding capacity were determined on d 1 and 7. Percent saturation was calculated as the plasma iron (g/dL) divided by the total iron binding capacity (g/dL). Plasma iron on d 1 was 5429 g/dL (n=69) and increased to 84 46 g/dL (n=55) on d 7. Latent iron binding capacity was 3859 g/dL (n=69) on d 1 and increased to 351119 g/dL (n=55) on d 7. Total iron binding capacity increased from 10054 g/dL (n=69) on d 1 to 432 104 g/dL (n=55) on d 7. Percent saturation was 62 25 % (n=69) on d 1 and 21 13% (n=55) on d 7. Of the 69 piglets bled on d 1, 26% of the piglets had %SAT of 100%. Although the following calculation is speculative, it is instructive. A newborn, 1.5 kg piglet with a packed cell volume of 28% has available 86 mL of plasma containing 46 g iron and can bind an additional 33 g of iron. This suggests that only 33 of the 100000 g injected can be bound by transferrin. Thus a dramatic level of iron trafficking must occur over the first few days of life. A limitation of iron binding capacity at birth would be expected to impact the ability of piglets to "manage" injected iron and may put the piglet at risk of iron catalyzed oxidative damage early in life if the iron is released from iron dextran.

**Key Words:** Pig, Iron, Latent iron binding capacity

**174 Pepsin concentration and ambient pH but not the presence of meat and bone meal impacts the half-life of pepsin *in vitro*.** Y.R. Qiao\* and T.A. van Kempen, *North Carolina State University, Raleigh.*

To refine the incubation conditions and estimate the contamination of pepsin autolysates on *in vitro* digestibility of feed proteins, the deactivation and self-degradation of porcine pepsin at different pH and concentrations under *in vitro* condition were studied respectively by measuring the half-life of pepsin with the hemoglobin (Hb) method and o-phthalaldehyde (OPA) method. The half-life measured by the Hb method for pepsin at 0.05, 0.10 and 0.20 mg/mL was 3.0, 4.1 and 6.3 h at pH 2 and 4.6, 6.9 and 8.7 h at pH 4, respectively. The half-life measured by the OPA method for pepsin at 0.05, 0.10 and 0.20 mg/mL was 2.9, 3.5 and 5.8 h at pH 2 and 10.5, 9.1 and 9.1 h at pH 4, respectively. The half-life of pepsin at 0.5 mg/mL at pH 4 further increased to 14.4 and 16.7 h as measured by the Hb and OPA methods, respectively. The results showed that there were effects of pH ( $P < 0.01$ ) on the half-life and that pepsin exerted self-inhibitory effects on its deactivation and self-degradation ( $P < 0.001$ ). There was no difference ( $P = 0.67$ ) between the two methods in predicting the half-life, suggesting that deactivation coupled to self-degradation. The half-life of pepsin at 0.125 mg/mL incubated with meat and bone meal with pepsin/MBM protein ratio of 1% was not different from that at 0.10 mg/mL ( $P = 0.79$ ). Therefore, it seems that the concentration of pepsin and ambient pH but not the presence of meat and bone meal determines the half-life of pepsin *in vitro*. When pepsin was fully self-degraded, the average size of the autolysates was between 7.0 and 12.1 amino acid residuals, representing extensive degradation of pepsin. The study suggests that the contamination from pepsin autolysates on the *in vitro* digestible protein assay upon fractionation will be determined jointly by the concentration of pepsin, the pH, the incubation time and the enzyme/substrate ratio. In a short time and at high pepsin concentration, the contamination is likely negligible, especially when enzyme/substrate ratio is low.

**Key Words:** Pepsin, Half-life, *In vitro*

**175 Effects of phytase on growth performance and bioavailabilities of organic phosphorus and other nutrients in corn-soybean meal diets for young pigs.** Q.M. Yang\*<sup>1</sup>, S.K. Baidoo<sup>1</sup>, J.L.L. Boychuck<sup>2</sup>, and R.D. Walker<sup>1</sup>, <sup>1</sup>SROC, University of Minnesota, Waseca, MN 56093, <sup>1</sup>SROC, University of Minnesota, Waseca, MN 56093, <sup>2</sup>BASF (Canada), Todd Road, George Town, ON L7G 4R7, <sup>1</sup>SROC, University of Minnesota, Waseca, MN 56093.

Two hundred and sixteen weaning pigs (avg initial wt 5.8kg) were used to evaluate the effect of three dietary inorganic phosphorus content on growth performance, organic P utilization and other nutrient digestibilities in corn-soybean meal diets supplemented with microbial phytase (Natuphos®, BASF). Pigs were allocated to treatments based upon weight with 8 pigs per pen and 9 pens per treatment. The level of total phosphorus in the dietary treatments for the young pigs in phase 1 and 2, respectively, were (1) control, 0.72% and 0.62% P, (2) 0.67% and 0.57% P + phytase, (3) 0.62% and 0.52% P + phytase. All changes in dietary P levels were accomplished by reduction of dicalcium phosphate. Phytase was added to the phytase-supplemented diets at a level of 500 FTU/kg for both phases. Chromic oxide (0.2%) was added to the diets as a marker to determine nutrient digestibility. There were no differences in ADG or F/G in the starter phases (295.2, 310.9 and 297.0g/d for ADG and 1.64, 1.58 and 1.59, for F/G for the three dietary treatments respectively). The digestibility of organic P in the diets with phytase were higher ( $P < .01$ ) than the control diet (42.7 and 38.6% vs 29.8%). Fecal P excretion was decreased ( $P < .05$ ) by 17.5% and 15.8% compared to the control diet. However, the digestibilities of inorganic P, crude protein organic matter, crude ash were not influenced by dietary treatments. Serum inorganic phosphorus concentration in pigs fed Diet 2 was higher (118.9 mg/l) than 101.2 mg/l (Diet 1) and 105.1 mg/l (Diet 3) ( $P < .05$ ). In summary, phytase supplementation to reduce inorganic phosphate in diets fed to young pigs, maintained performance and digestibility of P, CP, OM and crude ash and decreased the excretion of fecal organic phosphorus.

**Key Words:** Piglets, Phosphorus, Phytase

**176 Efficacy of least-cost matrix values for Natuphos phytase additions to swine diets.** T.D. Crenshaw, J.A. Kane, M.R. Glenn, and D.K. Schneider, *University of Wisconsin, Madison.*

One hundred sixty, crossbred (Duroc x Large White x Landrace) gilts and barrows were used to validate least-cost matrix equivalencies for phytase. Pigs (5/pen) were randomly allotted within age, sex, and weight blocks and fed one of eight diets from 20 to 115 kg. Gilts and barrows were penned separately. Corn-SBM diets formulated to minimum requirements for Ca and P exceeded requirements for other nutrients. Formulations included least-cost matrix values for Natuphos phytase. Treatments included a positive control (1), a replicate control (2), and diets formulated to provide 300, 400, and 500 FTU/kg with (3, 5 & 7) and without (4, 6, & 8) phytase additions. No differences in growth or feed efficiency were detected among pigs fed control or diets with 300, 400 or 500 FTU/kg ( $P > .10$ ). Expected differences were detected in pigs fed diets using least-cost matrix values without phytase additions. Over the entire trial pigs fed diets without phytase at the 500 FTU/kg matrix level (Diet 8), gained only 70% as fast and required 25 days longer to reach market weight as pigs fed control diets ( $P < .05$ ). Feed efficiency was reduced by approximately 20%. No differences among treatment groups were detected in carcass data. Carcass results are biased by exclusion of pigs which did not reach market weight. Expected differences due to sex were detected in growth, feed efficiency and carcass traits, but interactions between sex and diet were not significant ( $P > .10$ ). Overall, results confirm the efficacy of phytase. Equal performance was obtained between pigs fed corn-SBM diets supplemented with inorganic P and diets with various levels of phytase. Pigs fed diets using matrix values without phytase failed to maintain equal performance. Substitution of phytase for inorganic P can be based on relative costs of ingredients without concerns for differences in animal growth or feed efficiency.

	1	2	3	4	5	6	7	8	SEM
Gain, kg/d	0.92	0.89	0.86	0.80	0.90	0.67	0.93	0.64	0.03
Feed:Gain	2.48	2.44	2.56	2.71	2.53	2.93	2.48	2.93	0.04

**Key Words:** Phytase, Phosphorus, Swine

**177 A simple *in vitro* procedure for predicting available phosphorus in feed ingredients for swine.** A. Tsunoda\*, D. W. Bollinger, D. R. Ledoux, and T. L. Veum, *University of Missouri, Columbia.*

A simple *in vitro* procedure to estimate available P for swine with 21 plant-origin and 2 animal-origin feed ingredients was tested using two different pancreatic digestion times. This procedure, a simplification of our *in vitro* procedure that uses dialyzing tubing (Liu et al., 1998), consisted of three enzymatic digestions in a 50 mL centrifuge tube: (1) Pre-digestion with endo-xylanase and beta-glucanase for 1 h, (2) pepsin digestion for 2 h, and (3) Pancreatin digestion for 2 or 4 h. Test ingredients were alfalfa meal, barley, low phytate barley (LPB), canola meal, corn, low phytate corn (LPC), grain sorghum, lentils, oats, peas, rice, rye, soft red winter wheat (SRW), soft white winter wheat (SWW), SWW high amylopectin (SWWA), hard red winter wheat (HRW), HRW high protein (HRWP), hard red spring wheat (HRS), HRS high protein (HRSP), wheat bran, dried skim milk (DSM), and dried whey. Repeatability was tested for each ingredient using six independent replications. Percentage of hydrolyzed P (HP) with 4 h pancreatic digestion was higher ( $P < 0.01$ ) in barley (30.9), rye (50.1), SWW (19.7), HRW (22.3) HRWP (26.7), HRSP (22.4) and DSM (56.1). Grain sorghum (8.7), LPB (44.5) and SWWA (22.2) exhibited a trend ( $P < 0.1$ ) for greater HP release with 4 h pancreatic digestion. There were no digestion time differences ( $P > 0.2$ ) in HP for alfalfa meal (87.4), canola meal (19.8), corn (15.3), LPC (48.0), lentils (21.5), oats (14.3), rice (8.1), SRW (30.0), HRS (23.1), wheat bran (24.8), and dried whey (66.3). A 2 h pancreatic digestion maximized ( $P < 0.01$ ) HP for Peas (18.6). This *in vitro* procedure was highly repeatable (99.4%). In conclusion, this simple alternative *in vitro* procedure can reduce pancreatic digestion time from 4 to 2 h for alfalfa meal, corn, LPC, lentils, oats, peas, rice, SRW, HRS, wheat bran, and dried whey. A 4 h pancreatic digestion is required for the other feed ingredients.

**Key Words:** Phosphorus, *In vitro*, Swine

**178 Effects of lowering dietary trace mineral (Fe, Zn, and Cu) concentrations on performance and bone characteristics of young pigs fed diets containing low phytic acid barley.** T. L. Veum<sup>\*1</sup>, D. W. Bollinger<sup>1</sup>, D. R. Ledoux<sup>1</sup>, M. S. Carlson<sup>1</sup>, and V. Raboy<sup>2</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>USDA-ARS National Small Grain Germplasm Research Facility, Aberdeen, ID.

An experiment was conducted to evaluate the nutritional value of a genetically modified, low phytic acid, mutant barley (MB). The estimated available P in MB is 95.5% compared to 30% in a near isogenic normal Harrington barley (HB). Crossbred barrows (n=50) averaging 9.94 kg, were housed individually for 28 days, with pigs as experimental units. Experimental design was completely random with a 2 x 5 factorial arrangement, MB and HB, and five levels of a trace mineral premix (0, 25, 50, 75, and 100%). Premix levels of Fe, Zn, and Cu at 100% provided 100, 100 and 160%, respectively, of NRC (1998) for 10-20 kg pigs in sulfate forms. All other nutrients were adequate. Pigs were sacrificed on day 28 for collection of the third metacarpal bone (3MC) and liver. There were no interactions (P >0.2) between barley type and mineral level. Thus, main effects demonstrate that MB and HB were of equal nutritional value for all criteria measured (P>0.3), except that HB exhibited a greater 3MC breaking strength (P<0.06). For pigs fed MB, there were linear increases in ADG (P<0.05), ADFI (P<0.01), liver weight (P<0.09) and 3MC wet weight (P<0.08) with increasing trace mineral addition. For pigs fed HB, there were linear increases in ADFI (P<0.05) and liver weight (P<0.1) and a quadratic response for 3MC breaking strength (P<0.02) with increasing levels of trace minerals. In conclusion, MB and HB were similar in nutritional value for growth performance with soybean meal as the protein supplement. For MB, most criteria increased with increasing trace mineral level.

**Key Words:** Trace minerals, Swine, Barley

**179 Effect of lower concentrations of copper proteinate compared to copper sulfate on mineral excretion of nursery pigs.** C. Wu<sup>1</sup>, A. Tsunoda<sup>1</sup>, D. W. Bollinger<sup>1</sup>, M. S. Carlson<sup>1</sup>, T. L. Veum<sup>\*1</sup>, and G. W. Tibbetts<sup>2</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>Alltech, Inc., Nicholasville, KY.

A 28-d experiment was conducted to evaluate the effect of lower concentrations of an organic source of Cu as Cu proteinate (Bioplex Cu, Alltech, Inc., Nicholasville, KY) on Cu excretion by nursery pigs, compared to 250 ppm Cu of an inorganic source from CuSO<sub>4</sub>. Crossbred barrows (n=20) averaging 11.22 kg, were allotted to four dietary treatments: (1) Basal diet, (2) Basal + 50 ppm Cu as Cu proteinate (Cu-P), (3) Basal + 100 ppm Cu as Cu-P, and (4) Basal + 250 ppm Cu as CuSO<sub>4</sub>. The basal diet contained 19.39% CP, 1.25% total lysine, 0.39% methionine, 165 ppm Zn as ZnSO<sub>4</sub>, 165 ppm Fe as FeSO<sub>4</sub>, 16.5 ppm Cu as CuSO<sub>4</sub>, and 0.05% Cr<sub>2</sub>O<sub>3</sub> as a non-digestible indicator. Pigs were individually penned in metabolism cages. On day 0 and 28 of the experiment, blood samples were collected and BW was measured. Fecal samples and total urine collections were made twice daily from day 22 to 26. There were no treatment differences in growth performance criteria (P>0.40). Pigs fed CuSO<sub>4</sub> excreted the most Cu (P<0.05) in feces (325 mg/d) followed by pigs fed 100, 50 or 0 ppm Cu as Cu-P (124, 73 or 27 mg/d, respectively). Pigs fed either Cu-P or CuSO<sub>4</sub> excreted (P<0.05) more Cu in urine and retained more Cu (mg/d) than pigs fed the basal diet, with pigs fed CuSO<sub>4</sub> retaining the most Cu. Digestibility and retention of Cu as a % of intake were greater for pigs fed CuSO<sub>4</sub> or Cu-P (P<0.05) than for pigs fed the basal diet. Pigs fed Cu-P had a trend (P<0.07) for a linear increase in plasma Cu on day 28, with increasing dietary Cu-P. In conclusion, Cu digestibility and retention (mg/d and %) were increased by Cu-P, with even greater increases for pigs fed CuSO<sub>4</sub>. However, Cu excretion in manure (mg/d) was greatly increased with CuSO<sub>4</sub> compared to Cu-P.

**Key Words:** Copper, Excretion, Swine

**180 Effect of lower concentrations of zinc proteinate compared to zinc oxide on mineral utilization by nursery pigs.** C. Wu<sup>1</sup>, A. Tsunoda<sup>1</sup>, D. W. Bollinger<sup>1</sup>, M. S. Carlson<sup>\*1</sup>, T. L. Veum<sup>1</sup>, and G. W. Tibbetts<sup>2</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>Alltech, Inc. Nicholasville, Kentucky, USA.

A 28-d experiment was conducted to evaluate the effect of lower concentrations of an organic source of Zn as Zn proteinate (Bioplex Zn,

Alltech, Inc., Nicholasville, KY) on growth performance and Zn excretion by nursery pigs, compared to 2000 ppm Zn of an inorganic source from ZnO. Twenty crossbred barrows averaging 11.21 kg, were allotted to four dietary treatments: (1) Basal diet, (2) Basal + 200 ppm Zn as Zn proteinate (Zn-P), (3) Basal + 400 ppm Zn as Zn-P, and (4) Basal + 2000 ppm Zn as ZnO. The basal diet contained 19.39% CP, 1.25% total lysine, 0.39% methionine, 165 ppm Zn as ZnSO<sub>4</sub>, 165 ppm Fe as FeSO<sub>4</sub>, 16.5 ppm Cu as CuSO<sub>4</sub>, and 0.05% Cr<sub>2</sub>O<sub>3</sub> as a non-digestible indicator. Pigs were individually penned in metabolism cages. On day 0 and 28 of the experiment, blood samples were collected and BW was measured. Fecal samples and total urine collections were made twice daily from day 22 to 26 of the experiment. Overall (d 0-28), there was a trend (P<0.10) for pigs fed ZnO to have higher ADFI and ADG compared to the other treatments. Pigs fed ZnO excreted more (P<0.05) fecal (2109 mg/d) and urinary Zn (44 mg/d) than the other treatments which ranged from 195 to 436 mg/d for fecal Zn and 3.5 to 7.0 mg/d for urinary Zn. Zn retention (mg/d) was increased by the addition of Zn-P or ZnO, with pigs fed ZnO having the highest Zn retention. There was a trend (P<0.10) for digestibility and retention of Zn as a % of intake to be higher for pigs fed 400 ppm Zn as Zn-P compared to pigs fed 0 or 200 ppm Zn as Zn-P. There were no differences (P>0.50) in plasma Zn concentration among the treatments. In conclusion, Zn intake, excretion, and retention (mg/d) were the highest with ZnO. There was a small increase in these criteria for the 400 ppm Zn as Zn-P treatment compared to the remaining treatments.

**Key Words:** Zinc, Excretion, Swine

**181 Effects of yeast supplementation to diets with or without growth promoting levels of copper, zinc and antibiotics on growth performance of weanling pigs.** E. van Heugten<sup>\*</sup> and K. L. Dorton, North Carolina State University, Raleigh.

An experiment was conducted using 96 weanling pigs (17 days old, 6.50 kg initial BW) to evaluate the effect of live yeast (BIOSAF<sup>®</sup>) supplementation on growth performance of pigs fed diets with or without pharmacological levels of copper and zinc and antibiotics. Pigs were allotted to 24 pens based on body weight, gender, and litter of origin and received one of four dietary treatments arranged in a 2 x 2 factorial in a randomized complete block design. Factors consisted of: 1) diet type (Commercial type, supplemented with high levels of Cu (240 ppm), Zn (2,500 ppm during the prestarter period only), and antibiotics (400 g/ton CTC and 35 g/ton tiamulin during the prestarter and 100 g/ton of tylosin/sulfamethazine during the starter period) or negative control without growth promoters) and 2) yeast supplementation (0 or 2.4 x 10<sup>7</sup> CFU/g of diet). Yeast survivability was 96% following pelleting at 60°C and analyzed yeast counts averaged 2.5 x 10<sup>7</sup> CFU/g of diet. Pigs fed the commercial type diet had greater daily gain (506 vs. 460 g/d; P < 0.001) and feed intake (691 vs. 650 g/d; P < 0.04) and tended to have a greater gain:feed ratio (0.73 vs. 0.71; P = 0.10) for the 6-week experimental period. Yeast supplementation improved daily gain (495 vs. 471 g/d; P < 0.01). Interactive effects between diet type and yeast supplementation were observed for daily gain (P < 0.01) and feed intake (P < 0.10). Yeast supplementation to the commercial type diet improved daily gain (531 vs. 480 g/d; P < 0.001), but had no effect (P > 0.80) when supplemented to the negative control diet (462 vs. 459 g/d). Feed intake was increased (P < 0.03) in pigs fed the commercial type diet supplemented with yeast (722 vs. 660 g/d), but not (P > 0.75) when supplemented to the negative control diets (647 vs. 654 g/d). These results indicate that yeast supplementation worked in concert with other growth promotants used in this experiment in improving gain and feed intake, but was not effective in diets without these growth promoters.

**Key Words:** Yeast, Pigs, Growth

**182 Effects of dietary zinc and endotoxin challenge on the acute phase response in weanling pigs.** S.L. Mandali<sup>\*</sup>, S.D. Carter, A.B. Arquitt, E.A. Droke, B.J. Stoecker, L.J. Spicer, and M.J. Rincker, Oklahoma State University, Stillwater.

A 2 x 4 factorial arrangement of treatments was used to determine the effects of dietary Zn concentration and endotoxin challenge in weanling pigs. Forty-eight weanling pigs (5.5 kg; 15 d) were housed individually and allotted randomly to four liquid diets. Dietary treatments were prepared by adding ZnSO<sub>4</sub> to a commercial milk replacer (MR, 5 ppm Zn) to provide 0, 100, 1,500, or 3,000 ppm added Zn. Diets were mixed prior to feeding by adding 12 g of MR to 100 mL of deionized water.

The diets were fed 4 times/d for 14 d. On d 14, pigs were fasted 10 h and injected i.p. with saline or 25 ug LPS (*E. coli*. 0111:B4)/kg BW. Blood samples and temperature were collected at 0 h (before injection), and at 3, 6 and 24-h post injection (PI). Growth performance from d 0-14 was not affected ( $P > .10$ ) by dietary Zn. On d 14 (prior to LPS), plasma Zn concentrations for the 4 dietary treatments were, respectively: .36, 1.09, 3.50, and 4.30 mg/L (linear,  $P < .01$ ). Increasing dietary Zn decreased (linear,  $P < .01$ ) C-reactive protein (CRP), albumin, and cortisol, but increased (linear,  $P < .01$ ) triglycerides and urea nitrogen. A biphasic response was observed over time for temperature, white blood cells, neutrophil, and lymphocyte counts in pigs injected with LPS, but no response was noted in control pigs (LPS  $\times$  time,  $P < .01$ ). Body temperature and cortisol increased up to 6 h in LPS-injected pigs, and then decreased to baseline values by 24-hr PI (LPS  $\times$  time,  $P < .01$ ). Plasma Zn and CRP increased with increasing Zn at 0 and 24-h PI, but quadratic responses were noted at 6 h (Zn  $\times$  time;  $P < .01$ ). Increasing Zn decreased insulin in control pigs, but increased it in LPS-injected pigs (Zn  $\times$  LPS,  $P < .01$ ). These results suggest that endotoxin challenge has a marked effect on the acute phase response in weanling pigs. Dietary Zn affected some measures of the acute phase response independent of endotoxin challenge. This suggests that dietary Zn has minimal effects on the response of weanling pigs to endotoxin challenge.

**Key Words:** Weanling pigs, Zinc, Endotoxin

### 183 Effect of a mannan oligosaccharide on growth of nursery pigs. F. M. LeMieux\*, L. L. Southern, and T. D. Bidner, *LSU Agricultural Center, Baton Rouge, LA.*

Four Exp. were conducted to determine the effect of a mannan oligosaccharide (Bio-Mos, BM) on growth of pigs. Treatments were replicated with five to six pens of four to five pigs each. Initial BW ranged from 4.7 to 5.4 kg, and pigs were weaned at 16 to 20 d of age. Experiments 1, 2, and 4, consisted of Phase 1 (7 to 8 d), Phase 2 (12 to 14 d), and Phase 3 (7 to 8 d) periods. Experiment 3 consisted only of Phase 1 (7 d) and 2 (14 d) periods. The diets for Phase 1, 2, and 3 contained 1.6, 1.5, and 1.1% Lys, respectively. In Exp. 1, pigs were fed 0, 0.20, or 0.30% BM in diets containing 3,000 ppm Zn and an antibiotic. Bio-Mos did not affect ( $P > 0.10$ ) growth performance. In Exp. 2, pigs were fed two levels of Zn (0 or 3,000 ppm) and/or three levels of BM (0, 0.20, or 0.30%), and all diets contained an antibiotic. Growth performance was not affected ( $P > 0.10$ ) during Phase 1. During Phase 2, 3, and overall, excess Zn increased ADG ( $P < 0.08$ ) and ADFI ( $P < 0.01$ ). In the overall data, the 0.20% BM was as effective as excess Zn in increasing ADG and ADFI (Zn  $\times$  BM,  $P < 0.07$ ). In Exp. 3, pigs were fed two levels of Zn (0 or 3,000 ppm) and/or two levels of BM (0 or 0.20%), and all diets contained an antibiotic. Excess Zn decreased ( $P < 0.07$ ) ADG in Phase 1, but increased ( $P < 0.09$ ) ADG and ADFI in Phase 2. The BM addition increased ADG and gain:feed during Phase 2 and overall; the response to BM in gain:feed but not ADG was similar to that observed for Zn, and the effects due to Zn and BM were not additive (Zn  $\times$  BM,  $P < 0.06$ ). In Exp. 4, pigs were fed 1) basal diet without excess Zn or antibiotic (B), 2) B+antibiotic, 3) B+0.20% BM, 4) B+3,000 ppm Zn, 5) B+antibiotic+BM, or 6) B+BM+Zn. In the overall data, pigs fed Diets 2, 4, or 5 had increased ( $P < 0.10$ ) ADG and ADFI compared with pigs fed Diet 1. Similarly, pigs fed Diets 2, 4, 5, or 6 had increased ( $P < 0.10$ ) ADG and ADFI compared with pigs fed Diet 3. Bio-Mos improved growth performance in some experiments but not others, and it seemed to be most effective during Phase 2 periods.

**Key Words:** Pig, Mannan Oligosaccharide, Zinc

### 184 Evaluation of differences in mean body surface temperature and radiant heat loss in growing pigs with infrared thermography. J. A. Loughmiller\*, M. F. Spire, M. D. Tokach, S. S. Dritz, J. L. Nelssen, R. D. Goodband, and S. B. Hogge, *Kansas State University, Manhattan.*

Eighty barrows were used to evaluate the relationships among feed intake, diet composition, mean body surface temperature (MBST), and mean body surface heat loss (MBSL). In Exp. 1, pigs (initially 25 kg) were allotted in a randomized complete block design to one of four feed intake levels (0.75, 1.5, or 2.50  $\times$  ME<sub>maintenance</sub> and ad libitum). Restricted intake pigs were fed daily at 0730. Infrared (IR) thermographic images were collected at 0700, 1100, and 1900 h on d 4, 5, and 6 to measure changes in MBST and MBSL. For the respective treatments, ADG (-0.01, 0.64, 0.89, and 1.17 kg), ADFI (0.47, 0.86, 1.35, 1.64 kg),

and G/F (-0.03, 0.75, 0.67, 0.70) increased as ME intake increased (quadratic,  $P < 0.01$ ). Treatment  $\times$  time interactions were observed for MBST and MBSL ( $P < 0.01$ ). This was a result of linear ( $P < 0.05$ ) increases in MBST and MBSL as daily ME intakes increased at 0700 and 1900 h and a quadratic response ( $P < 0.05$ ) at 1100 h. In Exp. 2, pigs (initially 40 kg) were fed a common corn-soybean meal diet and IR images were collected daily at 0700 h. Regression analysis indicated ADG was best described by ADFI, MBSL, and natural log of MBST ( $r^2 = 0.38$ ;  $P < 0.01$ ). In Exp. 3, pigs (initially 59 kg) were allotted to one of four dietary energy levels (2.75, 3.0, 3.25, and 3.50 Mcal ME/kg) in a randomized complete block design. Increasing ME increased ADG (1.07, 1.14, 1.24, 1.28 kg), G/F (0.37, 0.35, 0.39, 0.41), ME intake (8.03, 9.88, 10.10, 10.96 Mcal/d), MBST (32.1, 32.5, 32.6, 32.8 C), and MBSL (-67.2, -70.7, -73.0, -74.8 kcal/h; linear,  $P < 0.05$ ). These experiments indicate that IR thermography can detect MBST and MBSL changes in growing pigs due to changes in ADFI or dietary energy level.

**Key Words:** Infrared thermography, Body heat loss, Pigs

### 185 Sorting growing-finishing pigs by weight fails to improve growth performance or reduce variation. P. R. O'Quinn\*, S. S. Dritz, R. D. Goodband, M. D. Tokach, J. C. Swanson, J. L. Nelssen, and R. E. Musser, *Kansas State University, Manhattan.*

Two trials were conducted, each using 192 crossbred barrows and gilts (initially 33.8 kg BW and 14 wk of age), to determine the effects of sorting growing-finishing pigs uniformly by weight on growth performance and variation. Pigs were balanced for sex and ancestry within and across replicates and allotted to one of four groups: heavy sorted (37.1  $\pm$  1.4 kg), medium sorted (34.0  $\pm$  0.8 kg), light sorted (30.2  $\pm$  2.0 kg), or to an unsorted group (33.8  $\pm$  3.2 kg) to provide 12 pigs per pen and eight replicate pens per experimental grouping. The unsorted pigs had similar starting weights but quadruple the within-pen standard deviation of the medium sorted pigs. As expected, initial variation among all groups of pigs was different ( $P < .05$ ). Pigs were fed nutritionally adequate grain-sorghum-soybean meal-based diets in three phases with decreasing nutrient density as pig weight increased. Overall (d 0 to 91), ADG of unsorted pigs and heavy sorted pigs was similar, but greater ( $P < .05$ ) than medium or light sorted pigs; ADFI was unaffected by grouping. All groupings were different ( $P < .05$ ) in final body weight and ranked in the following descending order: heavy sorted (123.4  $\pm$  7.4 kg), unsorted (119.9  $\pm$  8.7 kg), medium sorted (117.8  $\pm$  7.6 kg), and light sorted (113.2  $\pm$  9.3 kg). Final weight of unsorted pigs was heavier ( $P < .05$ ) than the average weight of all sorted pigs. Differences in body weight variation were not detectable ( $P > .05$ ) by the end of the study. The increase in pig weight from not sorting was primarily due to the growth performance of the medium weight pigs in unsorted pens. Medium pigs in these pens grew faster ( $P < .05$ ) than the medium weight pigs penned uniformly by weight (.97 versus .92 kg/d, respectively). These data suggest that sorting pigs by weight does not improve growth performance or reduce weight variation, and not sorting pigs may actually increase throughput (amount of pork produced) in a production system.

**Key Words:** Pigs, Sorting, Variation

### 186 The effects of graded levels of chromium propionate on growth, carcass traits, pork quality, and plasma NEFA concentrations of growing-finishing pigs. R. L. Payne\*, S. L. Johnston, J. L. Shelton, J. O. Matthews, J. E. Pontif, T. D. Bidner, and L. L. Southern, *LSU Agricultural Center, Baton Rouge.*

Two Exp. were conducted with pigs to evaluate the effects of chromium propionate on growth, carcass traits, pork quality, and fasting NEFA concentrations. Average initial and final BW were 26 and 28 kg, and 111 and 112 kg for Exp. 1 and Exp. 2, respectively. In Exp. 1, the treatments were a corn-SBM diet with 0, 100, 200, or 300 ppb Cr. Each treatment was replicated six times with six barrows each. In the late-finishing period, ADFI was decreased (linear,  $P < 0.01$ ) as Cr concentration increased. Carcass traits were not affected ( $P > 0.10$ ) by Cr in Exp. 1. Plasma urea N (linear,  $P < 0.02$ ) and NEFA (quadratic,  $P < 0.06$ ) concentrations were decreased in pigs fed Cr. Total cholesterol (TC) and high-density lipoprotein (HDL) concentrations were increased (quadratic,  $P < 0.09$ ) in pigs fed 100 or 200 ppb Cr. Low-density lipoproteins, triglycerides, and TC:HDL were not affected by diet ( $P > 0.10$ ). In Exp. 2, the treatments were a corn-SBM diet with 0, 50, 100, or 200 ppb Cr. Each treatment was replicated six times with four gilts each.

The data from the 0 and 200 ppb Cr treatments are the same as Shelton et al. in this publication. Gain:feed was increased as Cr concentrations increased (linear,  $P < 0.02$ ) in the late-growing period. In the early-finishing period, ADFI was decreased (quadratic,  $P < 0.06$ ) in pigs fed 50 or 100 ppb Cr. Ham weight, fat-free lean in the ham and carcass, and kilograms of lean were increased (linear,  $P < 0.09$ ) as Cr concentration increased. Lean:fat was increased (quadratic,  $P < 0.07$ ) as Cr concentration increased. Percentage lean was decreased (quadratic,  $P < 0.04$ ) in pigs fed 50 or 100 ppb Cr but not in pigs fed 200 ppb Cr. Cooking loss and total loss in a frozen chop were decreased (linear,  $P < 0.05$ ) as Cr concentrations increased. The addition of Cr had no effect on NEFA concentrations ( $P > 0.10$ ). Chromium propionate may decrease ADFI, increase muscling, and improve pork quality.

**Key Words:** Chromium Propionate, NEFA, Carcass, Pig

**187 Effect of chromium propionate in low energy diets on growth, carcass traits, pork quality, and plasma NEFA concentrations in growing-finishing gilts.** J. L. Shelton\*, R. L. Payne, L. L. Southern, and T. D. Bidner, *LSU Agricultural Center, Baton Rouge.*

An Exp. was conducted to determine the effect of Cr propionate (Cr-Prop) on growth, carcass traits, pork quality, and plasma NEFA in pigs. Crossbred gilts (initial and final BW of 28 and 111 kg) were allotted to four treatments: 1) corn-soybean meal diet (C-SBM), 2) C-SBM + 200 ppb Cr, 3) C-SBM + 20% wheat midds (C-SBM-WM), 4) C-SBM-WM + 200 ppb Cr. There were six replications with four gilts each. The data from 0 and 200 ppb Cr in C-SBM diets are the same as Payne et al. of this publication. A four-phase feeding program was used and diets for this Exp. were formulated to provide 105% of the true digestible Lys requirement, and the ratio of Lys to NE was held constant. Pigs fed C-SBM tended to have an increased ( $P=0.12$ ) ADG and an increased gain:feed ( $P<0.07$ ) relative to pigs fed C-SBM-WM. Loin muscle area, dressing percentage, and kilograms of lean (NPPC) were increased in pigs fed CrProp in C-SBM but decreased in pigs fed C-SBM-WM (Cr x NE,  $P<0.05$ ). Lean gain per day tended to be decreased in pigs fed CrProp ( $P=0.11$ ). Percentage fat and intramuscular fat were decreased in pigs fed C-SBM-WM relative to pigs fed C-SBM ( $P<0.10$ ). Total loss (drip + cook) of a fresh chop was decreased in pigs fed CrProp in C-SBM-WM but not affected in pigs fed C-SBM (Cr x NE,  $P<0.08$ ). Total loss of a frozen chop was decreased in pigs fed CrProp in C-SBM but not affected in pigs fed C-SBM-WM (Cr x NE,  $P<0.05$ ). Cook loss of a previously frozen chop was decreased in pigs fed CrProp ( $P<0.03$ ). Rectal temperature was decreased in pigs fed C-SBM relative to those fed C-SBM-WM ( $P<0.01$ ). Rectal temperature was decreased in pigs fed CrProp in C-SBM but not affected in pigs fed C-SBM-WM (Cr x NE,  $P<0.08$ ). In the early-finisher phase, fasting plasma NEFA levels were decreased in pigs fed CrProp ( $P<0.05$ ). These data indicate that the addition of CrProp to low energy diets did not improve carcass traits, but CrProp in low energy diets may improve pork quality.

**Key Words:** Chromium Propionate, Energy, Swine

**188 Effect of chromium propionate on growth, carcass traits, and pork quality of finishing gilts.** J. O. Matthews\*, F. M. LeMieux, A. C. Guzik, L. L. Southern, T. D. Bidner, and M. A. Persica, *Louisiana State University Agricultural Center, Baton Rouge.*

An experiment was conducted to determine the effect of dietary Cr propionate on growth, carcass traits, and pork quality of crossbred finishing gilts. Dietary treatments were 0 or 200 ppb Cr (as Cr propionate) and each treatment was replicated four times with five gilts. Gilts were fed diets containing 0.82% lysine from 73 to 80 kg BW and 0.64% lysine from 80 to 115 kg BW. At trial termination, carcass and pork quality data were collected from four gilts per replicate. Average daily gain, ADFI, and gain:feed were not affected ( $P > 0.10$ ) by Cr propionate. Prior to delivery at the abattoir, shrink loss was determined after a 18 h fast (fasting shrink) and after hauling (shipping shrink) pigs for 2.66 h (206 km). Fasting shrink and overall shrink were not affected ( $P > 0.15$ ) by Cr propionate; however, shipping shrink tended ( $P = 0.14$ ) to be decreased in pigs fed Cr propionate. Carcass length was increased ( $P = 0.03$ ) in pigs fed Cr propionate. Loin muscle area, tenth rib backfat thickness, average backfat thickness, dressing percentage, muscle score, fat-free lean, and percentage lean were not affected ( $P > 0.10$ ) by Cr propionate. Ultimate loin pH was increased ( $P = 0.10$ ) in pigs fed Cr

propionate, but initial loin and ham pH and ultimate ham pH were not affected ( $P > 0.10$ ) by Cr propionate. Subjective (color, marbling, firmness, and wetness) and objective (CIE  $L^*a^*b^*$ ) assessments of the loin muscle (at the tenth-rib interface) were not affected ( $P > 0.10$ ) by Cr propionate. Forty-eight hour drip loss was decreased ( $P = 0.10$ ) in pigs fed Cr propionate, but cook loss, total loss (drip + cook loss), and shear force were not affected ( $P > 0.10$ ) by Cr propionate. These data indicate that Cr propionate may have the potential to improve some aspects of pork quality (ultimate loin pH and 48-h drip loss) and to reduce shrink loss due to shipping.

**Key Words:** Pigs, Chromium propionate, Meat quality

**189 Effect of nutritional level while feeding ractopamine to late-finishing pigs.** C.T. Herr\*, D.C. Kendall, A.P. Schinckel, and B.T. Richert, *Purdue University, West Lafayette, IN.*

Ninety-six barrows (initial BW = 69.6 kg) were allotted by weight to evaluate the effects of dietary lysine levels while feeding ractopamine (RAC) on growth performance and carcass traits. Treatments (trt) 1-3 were fed throughout the six-week trial, while trt 4 changed weekly. Trts were as follows: 1) 16% CP, .82% lys control diet; 2) 16% CP diet, .82% lys; 3) 18% CP diet, .97% lys; 4) a phase fed diet sequence; 18% CP, 1.08% lys during wk 1 and 4, 20% CP, 1.22% lys during wk 2 and 3, 16% CP, .94% lys during wk 5, and a 16% CP diet, .82% lys during wk 6. All diets in trts 2, 3, and 4 contained 20 ppm RAC. Treatment 4 was designed to meet the estimated lys requirements based on the modeled RAC lean growth from previous research. Pigs were marketed when the weight block reached 108.8 kg. Pigs fed trt 4 grew faster in wk 1 (1.42 vs 1.23 kg/d;  $P<0.05$ ) with reduced ADFI (2.82 vs 3.02 kg/d;  $P<0.05$ ) and increased gain:feed (.53 vs .44;  $P<0.05$ ) compared to the control trt. During wk 2, ADG increased (1.32 vs 1.16 kg/d;  $P<0.05$ ) as well as G:F (.47 vs .38;  $P<0.05$ ) when comparing the phase fed diet to the control diet. No significant differences were observed during wk 3. During wk 4, ADFI was decreased (2.53 vs 2.87 kg/d;  $P<0.05$ ) for pigs fed trts 3 and 4 compared to the control. No significant differences were observed in wk 5 and 6, however all pigs fed RAC had numerically lower ADG compared to the control pigs during wk 5. All pigs fed RAC had reduced 10th rib fat thickness (15.8 vs 19.8 mm;  $P<0.05$ ), increased LEA (47.6 vs 45.3  $\text{cm}^2$ ;  $P<0.05$ ), and increased % lean (56.5 vs 54.3%;  $P<0.05$ ). Carcass yield was higher (77 vs 75.5%;  $P<0.05$ ) for pigs fed the phase fed diet compared to the control diet. RAC had no effect on pork quality parameters. Feeding a 16% CP (.82% lys) diet with RAC results in no improvement in growth rate and minimal improvement in carcass traits compared to control trt. This trial would indicate that a four-week late-finishing program feeding RAC in conjunction with the phase fed trt would yield the best return on investment, with performance improvements compensating for the higher CP diet costs and the increased carcass premiums expected to pay for the RAC added to the diet.

**Key Words:** Pigs, Finishing, Ractopamine

**190 Evaluation of three genetic populations of pigs for response to increasing levels of ractopamine.** C.T. Herr\*, S.L. Hankins, A.P. Schinckel, and B.T. Richert, *Purdue University, West Lafayette, IN.*

Gilts ( $n = 300$ ; Initial BW = 83.5 kg) were allotted by weight in a 3 x 4 factorial with 3 genotypes (L1, L2, and L3) and 4 ractopamine (RAC) treatments (trt): 1) control, no RAC; 2) 5 ppm RAC; 3) 10 ppm RAC; 4) 20 ppm RAC to evaluate the effects of genotype and RAC trt on growth performance and carcass traits. All pigs were fed an 18.6% CP, 1.1% lys diet. Pigs were marketed after 4 weeks on their allotted trt. Pigs fed RAC had increased ADG (1.01 vs .88 kg/d;  $P<0.05$ ) compared to the control trt and L3 had increased ADG (1.03 vs .95 kg/d;  $P<0.05$ ) compared to L1 and L2 during the 4-wk trial. The 20 ppm RAC trt had reduced ADFI (2.48 vs 2.61 kg/d;  $P<0.05$ ) compared to the 10 ppm RAC and L2 had a lower ADFI (2.43 vs 2.71 kg/d;  $P<0.05$ ) than L1 and L3. Pigs fed RAC had improved gain:feed (.40 vs .33;  $P<0.05$ ) compared to the control trt, however no differences were observed in gain:feed between genotypes. Pigs fed RAC had increased final BW (111.5, 115.1, 115.3, 115.7 kg; trt 1-4 respectively,  $P<0.05$ ) and L1 had an increase in final BW (115.6 vs 113.2 kg;  $P<0.05$ ) compared to L2. Pigs fed RAC had increased hot carcass weight (HCW; 85.7 vs 81.8 kg;  $P<0.05$ ) compared to the control trt. In addition, L1 had an increase in HCW (86.3 vs 83.9 kg;  $P<0.05$ ) compared to L2 and L3. The 20 ppm RAC trt had decreased

Fat-O-Meter fat depth (16.4 vs 17.8 mm;  $P < .05$ ) and increased Fat-O-Meter loin depth (6.09 vs 5.57 cm;  $P < .05$ ) compared to the control trt. In addition, 20 ppm RAC had increased Fat-O-Meter loin depth (6.09 vs 5.77 cm;  $P < .05$ ) compared to the 5 ppm RAC. A difference in dressing percentage was also observed between all three genotypes (73.0, L3; 74.1, L2; 74.7%, L1;  $P < .05$ ). Pigs fed RAC had increased predicted % lean (55.7 vs 54.7 %;  $P < .05$ ) compared to the control trt. As the level of RAC was increased in the diet, growth performance and carcass traits were improved. However, 85% of the increase in ADG and 90% of the carcass improvements in all 3 genotypes was observed at the 5 ppm RAC level.

**Key Words:** Genetics, Finishing, Ractopamine

**191 Effect of ractopamine and lysine levels on growth and carcass responses in finishing gilts.** D.R. Cook\*, E.A. Newton, W.H. Turlington, K.R. Cera, and K.L. Adams, *Akey, Inc., Lewisburg, OH.*

The objective of this 6 wk trial was to determine the effects of dietary ractopamine (RAC) and lysine levels on growth performance and carcass characteristics of 80 PIC terminal cross gilts. At approximately 70 kg BW, gilts were penned individually (1.9 m<sup>2</sup>/gilt) and fed a corn-soy diet (0.81% lysine) containing tylosin (40 g/ton) for 7 d. Gilts were then randomly allotted, based on BW, to diets containing 10, 15, or 20 ppm RAC and 0.97, 1.12, or 1.27% dietary lysine (3×3 factorial). After 4 wk the lysine levels were adjusted to 0.85, 0.97, and 1.08%, respectively. Eight control (C) gilts remained on the 0.81% lysine diet for wk 1-4 and 0.74% lysine for wk 5-6. All gilts were given ad libitum access to feed and water. At termination of the trial, all gilts were slaughtered at Hatfield Quality Meats, Hatfield, PA. During wk 1-4, the main effect of RAC level indicated similar ADG (1266, 1238, 1270 g/d,  $P = .68$ ) and gain:feed ratios (474, 487, 494 g/kg,  $P = .22$ ) but lower ADFI (2685, 2540, 2572 g/d,  $P = .11$ ) as dietary RAC level increased. Main effects of lysine indicated higher ADG (1229, 1243, 1302 g/d,  $P = .13$ ) and improved gain:feed ratios (467, 486, 500 g/kg,  $P = .03$ ) but similar ADFI (2626, 2540, 2663 g/d  $P = .47$ ) as dietary lysine increased. No RAC × lysine interactions were observed ( $P > .15$ ). ADG, ADFI, and gain:feed ratios of C gilts in wk 1-4 were 1125 g/d, 2708 g/d, and 416 g/kg, respectively. During wk 5-6, no growth response to RAC was apparent. Increasing RAC level decreased 10<sup>th</sup> rib backfat (16.0, 14.5, 12.4 mm,  $P = .04$ ), and increased LEA (53.3, 55.1, 58.6 cm<sup>2</sup>;  $P = .11$ ). Control gilts had 22.6 mm 10<sup>th</sup> rib backfat and 47.7 cm<sup>2</sup> LEA. Increasing lysine resulted in a linear decrease in 10<sup>th</sup> rib backfat for 20 ppm RAC pigs, but not for 10 and 15 ppm RAC pigs (RAC × Lysine,  $P = .08$ ). Based on these data, muscle growth and fat deposition are responsive up to 20 ppm RAC, and growth performance is responsive to lysine levels as high as 1.27% in gilts fed RAC-supplemented diets.

**Key Words:** Ractopamine, Pigs, Growth

**192 Effects of feeding graded levels of ractopamine on pig performance in a commercial finishing facility.** R. G. Main\*, S. S. Dritz, M. D. Tokach, R. D. Goodband, and J.L. Nelssen, *Kansas State University, Manhattan.*

Our objective was to evaluate the impact of ractopamine HCl (Paylean<sup>®</sup>, Elanco Animal Health) supplementation during the final 21 days of the finishing period. Forty pens (880 pigs; initially 106.7 ± 0.5 kg) were used in a randomized complete block design in a 4 × 2 factorial arrangement. Main effects were added ractopamine (0, 5, 7.5, and 10 ppm) and gender (barrows and gilts). There were 20 to 23 pigs/pen and 5 pens/treatment. Diets were corn-soybean meal based and formulated to contain 0.7% and 0.9% total dietary lysine for the control and ractopamine supplemented diets, respectively. At slaughter, fat and loin depth were measured with an optical probe to calculate lean percentage. Fat and loin depth, and lean percentage were adjusted to a common carcass weight. Differences were observed ( $P < .01$ ) between pigs fed 0 ppm and 5, 7.5, or 10 ppm, respectively for daily gain (.77, .90, .91, .94 ± .03 kg/day) and feed efficiency (G:F; .28, .32, .34, .35 ± .01). However, no differences in gain were noted among pigs fed 5, 7.5, or 10 ppm of ractopamine. Pigs fed 10 ppm had greater G:F ( $P < .02$ ) compared with pigs fed 5 ppm, with pigs fed 7.5 ppm having intermediate G:F. No differences in ADFI were observed among treatments. Gender differences were not observed for ADG, ADFI, or G:F in this 21 day evaluation. Ractopamine supplementation did not affect lean percentage ( $P > 0.49$ ; 54.9, 55.2, 55.5, 55.6 ± 0.39%), backfat ( $P > 0.75$ ; 18.2, 18.0, 17.9, 17.5 ± 0.46 mm), loin depth

( $P > 0.67$ ; 60.5, 61.5, 62.4, 61.7 ± 1.1 mm), or yield ( $P > 0.12$ ; 75.7, 76.2, 76.3, 76.6 ± 0.23%). Gender differences in lean percentage (54.5 vs 56.2 ± 0.2% for barrow vs. gilt, respectively;  $P < .01$ ) and backfat (19.2 vs 16.5 ± 0.3 mm;  $P < .01$ ) were observed. Feeding 5 to 10 ppm ractopamine for 21 days prior to market improved growth rate and feed conversion in this study. Increasing ractopamine dosages from 5 to 10 ppm resulted in similar growth rate but improved feed efficiency.

**Key Words:** Ractopamine, Growth, Beta-agonist

**193 Response of barrows to phytase in lysine deficient diets.** M.C. Brumm\*, *University of Nebraska, Northeast Research & Extension Center, Concord.*

Crossbred barrows (n=780, 25.5 kg BW) were used to evaluate nutrient release formulation matrix values of phytase in corn-soy diets (13 pigs/pen and 12 reps/treatment). Phytase at 500 FTU/kg inclusion was assumed to release .01% lysine, .12% Ca and P and 10 kcal ME/kg. Diets were a positive control diet (UNL), diets formulated at 85% of the positive diet lysine level using corn and soybean meal (85), 85 diets formulated using phytase with nutrient release credits (PHY), PHY without phytase addition (NEG), and NEG with added Ca and P (MIN). Diets were switched on the week individual pens weighed 36, 59 and 86 kg. UNL diets were formulated to contain 1.00%, .88%, .73% and .60% lysine, and .34%, .30%, .25% and .21% available P for the respective weight ranges. ADG (kg/d) for the overall grow-finish period (110 kg final BW) was .80, .74, .73, .74, and .74 for the UNL, 85, PHY, NEG and MIN treatments, respectively. Corresponding daily lean gain containing 5% fat (kg/d) was .30, .27, .27, .27, and .27, respectively. Gain:feed for each treatment, respectively, was .340, .319, .306, .316, and .311. Comparing UNL to 85 resulted in improved ( $P < .005$ ) ADG, gain:feed and lean gain. There were no differences ( $P > .10$ ) in ADG or lean gain for 85, PHY, NEG and MIN. PHY had a lower gain:feed than 85 ( $P < .001$ ) and NEG ( $P < .01$ ) and was not different ( $P > .1$ ) from MIN. Metacarpal bone strength at slaughter (2 pigs/pen in replicates 5-8) was 199, 208, 204, 195 and 197 kg/cm<sup>2</sup> for UNL, 85, PHY, NEG and MIN, respectively. The claim for a .01% increase in lysine availability due to phytase addition was not supported as evidenced by the lack of improvement in performance for the MIN vs PHY treatments or the 85 vs PHY treatments. The lysine limitation in the PHY treatment appears to have been severe enough to prevent any response of phytase in improving Ca and P availability as evidenced by the PHY vs NEG and MIN vs NEG lack of differences in response and the bone breaking strength evaluation.

**Key Words:** Pigs, Phytase, Lysine

**194 Effects of a 28-day pre-slaughter withdrawal of supplemental dietary vitamins and minerals on vitamin content of pork, bone quality, and carcass bone fractures.** D. T. Shaw\*, D. W. Rozeboom, G. M. Hill, A. M. Booren, M. W. Orth, D. S. Rosenstein, and J. E. Link, *Michigan State University, East Lansing.*

The objectives of this study were to determine if supplement withdrawal (omission of dietary vitamin and trace mineral premixes and 2/3 reduction of inorganic P) 28-d pre-slaughter affects longissimus dorsi muscle (LDM) nutrient content, bone quality, and incidence of bone fractures at slaughter. The effects of adding 30% wheat middlings to corn-soybean meal based (CSBM) growing and finishing diets on LDM nutrient content and bone quality were also evaluated. Crossbred pigs (n = 32) were blocked by weight and randomly assigned to treatments using a 2 × 2 factorial design (with or without supplement withdrawal; CSBM or CSBM plus wheat middlings). Serum was collected during the withdrawal period to determine changes in concentrations of osteocalcin, an indicator of bone formation, and pyridinoline, an indicator of bone degradation. At slaughter, radiographs of lumbar vertebrae and femurs were taken to determine incidence of bone fractures, and LDM samples were collected. Third metacarpi were obtained to evaluate bone mineral density, ultimate shear strength, and percent ash. Supplement withdrawal did not affect Ca, P, Zn, Fe, Cu or thiamin content of the LDM; however, concentrations of riboflavin and niacin were decreased ( $P < .01$ ). Supplement withdrawal increased concentrations of serum osteocalcin and pyridinoline ( $P < .05$ ); the increases in bone turnover resulted in decreased bone mineral density, ultimate shear strength, and bone ash ( $P < .01$ ) of the metacarpi. Dietary wheat middlings increased LDM thiamin and niacin concentrations ( $P < .01$ ), but did not alter bone quality.



Neither supplement withdrawal nor wheat middlings affected the incidence of bone fractures at slaughter. The results of this study indicate that supplement withdrawal and dietary wheat middlings alter the nutrient content of pork. Additionally, supplement withdrawal increases bone metabolism and decreases bone quality.

**Key Words:** Swine, Vitamins, Minerals

**195 Conjugated linoleic acid supplementation increases belly weight in lean-genotype gilts.** L. A. Averette\*, M. T. See, and J. Odle, *North Carolina State University, Raleigh 27695.*

Both conjugated linoleic acid (CLA) and tallow supplementation have been shown to increase firmness of pork bellies. This study evaluated the combined effects of dietary CLA and supplemental fat in lean-genotype gilts (n=144). Gilts (49.3 kg) were randomly assigned to a 2 x 3 factorial arrangement of supplemental fat level and linoleic acid supplementation. Animals were slaughtered (96.9 kg) after a period of 47d. Supplemental fat treatments included 0%, 4% yellow grease, and 4% tallow. Linoleic acid treatments included 1% corn oil or 1% CLA (CLA-60, Natural Lipids, Norway). Lysine:calorie ratio was constant in all diets. There were no significant effects of CLA on ADG (0.87kg), G/F (0.38), or ADFI (2.26kg) ( $P > .10$ ). No effects of CLA were detected on carcass measurements including loin eye area, backfat depth, water holding capacity, marbling score, or Minolta L\*, a\*, or b\* values ( $P > .10$ ). Four percent supplemental fat improved G/F (0.37 vs .40 ± .01;  $P < .02$ ) and ADG (0.85 vs 0.88 ± .02 kg;  $P < .09$ ). CLA supplementation improved green weight (2.51 vs 2.69 ± .05 kg;  $P < .02$ ), pump weight (3.06 vs 3.28 ± .06 kg;  $P < .02$ ) and smoke weight (2.30 vs 2.45 ± .06;  $P < .08$ ) of pork bellies. No effects of supplemental fat level on belly weights were detected ( $P > .10$ ). Interactions between linoleic acid and supplemental fat level were not detected ( $P > .10$ ). In conclusion, CLA but not tallow supplementation increased belly weights and increased belly weight may result in improved belly processing characteristics.

**Key Words:** Conjugated linoleic acid, Belly firmness, Lean-genotype swine

**196 Influence of the level of inclusion of soybean meal and peanut meal in the diet on pork quality.** Y. Hyun\*, M. Ellis, and F. McKeith, *University of Illinois at Urbana-Champaign.*

The objective of this study was to determine the effect of inclusion level of soybean and peanut meal on pork quality. The treatments were 1) Protein source [soybean meal (SBM) vs peanut meal (PM)], and 2) Protein level [normal protein (NormProt) vs excess protein (ExProt) vs normal protein level plus excess synthetic amino acids (ExAA)] using 2 x 3 factorial arrangement. The ExAA diet was formulated to provide the same levels of amino acids as the ExProt diet. Diets were formulated with corn and soybean meal to meet or exceed NRC (1998) recommendations. From 63 to 84 kg BW, inclusion levels of SBM and PM for NormProt, ExProt, and ExAA were, respectively: 21.4 and 22.3%, 47.2 and 49.3%, and 17.3 and 18.1%. From 84 to 122 kg BW, inclusion levels of SBM and PM for the three dietary treatments were, respectively: 15.2 and 15.8%, 41.2 and 43.0%, and 11.3 and 11.8%. A total of 120 pigs (6 diets x 5 replicates x 4 pigs per replicate, the progeny of PIC line 337 boars and C22 sows) were raised over a 58-d test period. Pigs were offered feed ad libitum and had free access to water. At the end of the test period carcass and meat quality evaluation was carried out. There was no effect ( $P > 0.05$ ) of protein source on growth, and pork quality traits. Pigs fed the ExProt diet had a lower feed intake and grew slower ( $P < 0.05$ ) than those on the NormProt diet. Gain:feed ratio and carcass traits were similar ( $P > 0.05$ ) across the three protein level diets. There was an interaction between protein source and protein level ( $P < 0.05$ ) for Hunter b\* of fat and Hunter a\* of longissimus muscle. For PM fed pigs, the ExAA diet had higher fat Hunter b\* values than the ExProt diet. For the SBM fed pigs, longissimus Hunter a\* values were lower ( $P < 0.05$ ) for the ExAA than other diets; for PM fed pigs, Hunter a\* values were lowest ( $P < 0.05$ ) for the ExProt diet. Longissimus Hunter b\* values were higher ( $P < 0.01$ ) for the NormProt than the other protein level diets. Longissimus ultimate pH values were highest and drip loss was lowest ( $P < 0.05$ ) for the ExProt. The results of this study suggest no differences between SBM and PM and a relatively small effect of dietary protein level for pork quality traits.

**Key Words:** Soybean meal, Peanut meal, Pork quality

**197 Evaluation of a rendered poultry (Broiler) mortality product as a supplemental protein source for growing-finishing pig diets.** R. O. Myer\* and J. H. Brendemuhl, *University of Florida, Gainesville.*

A feeding trial was conducted to evaluate a rendered (dehydrated) poultry broiler mortality-soybean meal blended product (PS) as a supplemental protein source for growing and finishing pig diets. Fresh mortalities were collected daily from commercial broiler farms and stored frozen (-2C) on site. The frozen mortalities were transported to a central site, minced, blended with soybean meal (48%; SBM), dried (final product temp. - 120 to 130C), and cooled. The final rendered product contained about 45% dried broiler mortality. The PS analyzed (as fed basis) 6.3% moisture, 51.4% CP, 14.6% EE, 7.0% ash, and 2.9% lys. The feeding trial involved 72 crossbred pigs (27 to 111 kg; 6 reps) and compared corn based diets containing either SBM (48%) or PS as the supplemental protein source. Split sex feeding was done in three phases - 27 to 53, 53 to 81, and 81 to 111 kg. Nutritionally adequate diets within sex and phase were formulated to be similar in estimated dig. lys/ME. Over the entire growing-finishing period, pigs (both sexes) fed the PS diets had an ADG that was similar to ( $P > 0.10$ ) and F/G that was 9% better ( $P < 0.01$ ) than for pigs fed the SBM diets (0.95 vs. 0.93 kg; 2.67 vs 2.87). Estimated percentage carcass lean (ultrasound) was not affected by dietary treatment (53.4 vs 54.3%;  $P > 0.10$ ). The rendering of farm broiler mortalities produces a safe and nutritious protein feedstuff for pigs while offering a viable poultry mortality disposal option.

**Key Words:** Pigs, Poultry by-product meal, Broiler mortalities

**198 Effect of feeding *Bacillus* cultures on performance of growing-finishing swine and on pen cleaning characteristics.** M. E. Davis\*, D. C. Brown, D. L. Kirkpatrick, and C. V. Maxwell, *University of Arkansas, Fayetteville.*

Three experiments involving 350 crossbred barrows and gilts were conducted to determine the effect of *Bacillus* cultures (Microsource™ S, Developed by Agtech Products, Inc. and marketed by Loveland Industries, Inc.) on gain, efficiency, pen cleaning time, and manure dispersion time. Pigs were blocked by age, weight, litter, and sex and allotted randomly to pens. Treatments were randomly assigned to pens and a three-phase feeding program was utilized. Two dietary treatments (0 and 0.5% Microsource™ S) were fed throughout the starter, grower, and finisher phases. Pigs were weighed and feed intake was determined at the initiation and termination of each phase. Studies were terminated when pigs in each weight block averaged 104 kg. At the end of Exp. 1 and 3, pen cleaning time was determined and two solid manure mat samples were collected from build-up in each pen. A 4 g sample of each manure mat was dissolved in water at 25°C with stirring action to determine dispersal time of the solid manure. Data were combined and analyzed as a randomized complete block design with pen as the experimental unit. Average daily gain was similar between pigs fed the control diet and pigs fed Microsource™ S in all three phases. Gain:feed improved in pigs fed Microsource™ S in each phase although differences were significant only in the finisher phase ( $P \leq 0.05$ ) and overall ( $P \leq 0.05$ ). Although not significantly different, pen cleaning time at the end of the study was numerically reduced in pens in which pigs were fed Microsource™ S compared to pens in which pigs were fed the control diet. Time required to dissolve the manure mat was reduced ( $P \leq 0.01$ ) in samples collected from pens where Microsource™ S was fed when compared to samples from pens fed the control diet. This study indicates that feeding Microsource™ S improves feed efficiency in the finisher phase and in the overall growing-finishing period, and enhances the manure decomposition process.

**Key Words:** Swine, *Bacillus* cultures, Growth performance

**199 The effect of stress on the nutrient requirements of growing pigs.** N.S. Ferguson\*, *University of Natal, Scottsville, South Africa.*

An experiment was conducted to measure the effect of stress (reduced floor space) on nutrient requirements of pigs grown from 25 to 60 kg. Two hundred and sixty four female Large White x Landrace pigs were assigned to one of four dietary lysine treatments (13.3, 11.4, 9.5 and 7.6 g/kg) and one of three floor space treatments (2.0, 1.0 and 0.5 m<sup>2</sup>/pig). There were no significant interactions between lysine content and floor

space for any response. Over the weight range 25-40 kg there were differences in ADFI ( $P < 0.01$ ), ADG ( $P < 0.05$ ) and F:G ( $P < 0.001$ ) among lysine treatments but most of these differences had disappeared by 60 kg. Between 25 and 60 kg there were only differences ( $P < 0.05$ ) in ADFI among dietary treatments. Increasing lysine content significantly improved protein retention (PR) ( $P < 0.05$ ) and decreased lipid retention (LR) ( $P < 0.001$ ) between 25 and 60 kg which resulted in a significant improvement in empty body protein content (BP) ( $P < 0.001$ ) and a reduction in lipid content (BL) ( $P < 0.001$ ). Decreasing the floor space per pig resulted in a reduction in ADFI ( $P < 0.001$ ), ADG ( $P < 0.05$ ) and F:G ( $P < 0.05$ ) over all weight ranges, except 25-40 kg where there were no differences in F:G. There was a linear reduction in both PR ( $P < 0.001$ ) and BP at 60 kg ( $P < 0.05$ ) as space was reduced. Space allowance had no effect on LR or BL. The maximum rate of lysine retention was significantly ( $P < 0.05$ ) reduced when space allowance was reduced to 0.5 m<sup>2</sup>/pig irrespective of lysine intake and, therefore, lysine requirements (expressed in g/d) were reduced with increasing levels of stress. This does not necessarily warrant a reduction in the lysine concentration because ADFI is also reduced. Feeding to potential PR will still produce the best carcass and growth performance irrespective of the level of stress. The improved lysine retention associated with higher nutrient levels did not completely offset the adverse physiological effects of stress on reducing maximum PR but may partly counteract the reduced nutrient intake associated with a stress-related suppression of appetite. However, there were indications that feeding crowded pigs a lower lysine concentration may not further reduce the already diminished PR.

**Key Words:** Pigs, Stocking density, Lysine

## 200 Effects of a pellet binder on pellet quality and growth performance of finishing pigs. C. W. Starkey<sup>1</sup>, J. D. Hancock<sup>1</sup>, C. A. Maloney<sup>1</sup>, D. J. Lee<sup>1</sup>, L. J. McKinney<sup>1</sup>, and K. C. Behnke<sup>1</sup>, <sup>1</sup>Kansas State University.

A corn-soybean meal-based diet (5% fat added at the mixer) was steam-conditioned at 82 C, pelleted through a 3.8 cm-thick die (5 mm diameter holes), and cooled with ambient air. Pellet mill throughput was set at 1 ton/h. Treatments were the control diet with none, 0.5, 1, and 2% lignin sulfonate. Addition of the pellet binder decreased specific energy used during pelleting from 2.14 to 1.73 kWh/ton (linear effect,  $P < 0.003$ ). Also, pellet durability index increased from 50 to 83% as percentage pellet binder in the diet was increased from none to 2% (linear effect,  $P < 0.003$ ). In a second experiment, a corn-soybean meal-based diet (5% fat added at the mixer) was fed in meal form, pelleted form, and in pelleted form with 0.5% lignin sulfonate added to the formulation. Processing conditions were as in Exp. 1, except that motor load was set at 17% and throughput was allowed to fluctuate. Pellet durability index increased from 59 to 73% ( $P < 0.004$ ) and percentage fines at the pigs feeders decreased from 27 to 16% ( $P < 0.001$ ) with addition of the pellet binder. When the diets were consumed by the pigs (two pigs per pen and eight pens per treatment) gain/feed was 6.6% greater for those fed pellets vs the meal control ( $P < 0.04$ ). However, there were no differences in growth performance among pigs fed pellets without or with the pellet binder ( $P > 0.6$ ). No differences were observed for dressing percentage or last rib backfat thickness among pigs fed the various treatments ( $P > 0.35$ ). In conclusion, use of the pellet binder increased pellet quality without affecting growth performance of finishing pigs. Thus, the decision to use a pellet binder should be based on the value of enhanced milling characteristics and not on anticipated increases in growth performance of pigs.

Item	Control meal	Control pellet	Lignin sulfonate	SE
ADG, kg	1.05	1.09	1.08	0.03
ADFI, kg	2.88	2.77	2.81	0.08
Gain/feed	0.365	0.394	0.384	0.009
Dressing percentage	73.9	73.7	74.3	0.4
Last rib backfat, mm	28.5	26.8	27.6	1.2

**Key Words:** Pellet Binder, Lignin Sulfonate, Finishing Pigs

## 201 Effect of Availa<sup>®</sup> Cu level on rate and efficiency of body weight gain in nursery pigs. D.R. Cook<sup>\*1</sup>, M.M. Ward<sup>1</sup>, and T.M. Fakler<sup>2</sup>, <sup>1</sup>Akey, Inc., <sup>2</sup>Zinpro Corporation, Eden Prairie, MN.

Two nursery trials, each utilizing 792 pigs weaned at 16-19 days of age, were conducted to determine the effect of supplemental Availa<sup>®</sup> Cu copper amino acid complex (CuAA) level on the rate and efficiency of body weight gain. At weaning (5.2 kg BW), pigs were randomly allotted (22/pen, 0.25 m<sup>2</sup>/pig) to dietary treatments based on body weight within gender. Pigs were budget-fed a 4-phase dietary treatment regimen ad-libitum for 45 days. The six dietary treatments were 0, 25, 50, 100, and 200 ppm supplemental copper from CuAA, and 200 ppm supplemental copper from copper sulfate (CuSO<sub>4</sub>, positive control). Data were analyzed as a split-plot design with gender serving as the whole-plot and dietary treatment as the subplot. Linear and quadratic effects of CuAA were tested using coefficients for unequally spaced treatments. No trial × treatment nor gender × treatment interactions were detected ( $P > .10$ ). Main effects of treatment across both barns and genders are reported. During the first two phases (14 d; 5.2-8.4 kg BW), increasing CuAA levels linearly ( $P < .02$ ) increased ADG (207, 205, 220, 233, 237 g/d) while pigs fed CuSO<sub>4</sub> gained 232 g/d. No effect ( $P > .10$ ) on ADFI or gain:feed ratio was observed. During phases 3 and 4 (31 d; 8.4-23.4 kg BW), increasing CuAA levels linearly ( $P < .01$ ) increased ADG (477, 480, 482, 484, 507 g/d) and pigs fed CuSO<sub>4</sub> tended ( $P < .10$ ) to gain faster (499 g/d) than all treatments except 200 ppm CuAA. Over the duration of the trial, ADG increased linearly ( $P < .03$ ) in response to increasing CuAA levels (391, 391, 398, 403, 421 g/d). ADG for CuSO<sub>4</sub>-fed pigs (414 g/d) was not different ( $P > .10$ ) from 50, 100, and 200 ppm CuAA treatments. Based on these data, CuAA increases ADG linearly up to 200 ppm added copper. At 200 ppm copper, ADG of pigs fed CuAA or CuSO<sub>4</sub> is similar.

**Key Words:** Pigs, Copper, Growth

## 202 Effect of copper citrate (CC) and copper sulfate (CS) level on growth performance in weaned pigs. D.R. Cook<sup>\*1</sup>, T.A. Armstrong<sup>2</sup>, J.W. Spears<sup>2</sup>, and M.M. Ward<sup>1</sup>, <sup>1</sup>Akey, Inc., <sup>2</sup>North Carolina State University, Raleigh.

In each of two experiments, 924 pigs (5 kg BW; 16-19 d weaning) were randomly allotted (22/pen, 0.25 m<sup>2</sup>/pig) to supplemental dietary Cu levels of 0, 15, 31, 62, or 125 ppm from CC, or 125 and 250 ppm from CS. Pigs were given ad-libitum access to feed and water. Data were analyzed as a split-plot design with gender serving as the whole-plot and dietary treatment as the subplot. In Exp. 1, pigs were fed a common phase 1 diet for 5 d. In phase 2 (6.1-8.5 kg), CC improved ( $P < .03$  Q) ADG (192, 224, 249, 235, 237 g/d) and feed:gain (1.50, 1.40, 1.30, 1.34, 1.34 g/g). Pigs fed 250 ppm CS gained faster (256 g/d,  $P < .10$ ) than all other treatments while pigs fed 125 ppm CS gained faster (248 g/d,  $P < .10$ ) than 0 and 15 ppm CC treatments. From 5 to 22 kg BW, CC increased ADG (361, 372, 394, 387, 410 g/d,  $P < .02$  L). Pigs fed 125 (413 g/d) or 250 (409 g/d) ppm CS had similar ( $P > .10$ ) ADG to pigs fed 125 ppm CC. Pigs fed any of the supplemental Cu treatments had greater ( $P < .10$ ) ADFI vs the negative control (519, 543, 558, 555, 579 g/d CC; 568, 556 g/d CS). In Exp. 2, pigs were fed test diets immediately after weaning. The 125 ppm CS treatment was replaced with a 62 ppm CS treatment. From 5 to 22 kg BW, neither linear nor quadratic CC effects on ADG (378, 375, 388, 387, 404 g/d) were observed ( $P > .10$ ). Pigs fed 250 ppm CS grew faster (415 g/d,  $P < .08$ ) vs all treatments except 125 ppm CC. Pigs fed 62 ppm CS had similar ( $P > .10$ ) ADG (384 g/d) compared with all treatments except 125 ppm CC. On d 40, fecal analysis revealed increasing Cu excretion (232, 401, 395, 701, 1377 CC; 797, 2831 CS; ppm Cu/unit DM) with increasing dietary Cu levels ( $P < .01$  Q for CC) regardless of Cu source (62 ppm CC vs CS,  $P > .10$ ). Fecal color (1 to 5 scale) was darker with increasing dietary Cu (1.17, 1.17, 2.33, 2.50, 3.33 CC,  $P < .02$  Q; 2.17, 4.67 CS). These data suggest that low levels (15-31 ppm) of CC can stimulate growth in pigs. At higher Cu levels performance responses to Cu source are similar and fecal excretion of Cu varies with level of Cu fed.

**Key Words:** Copper, Pigs, Growth

**203 Effect of copper source on performance of weanling pigs.** C. V. Maxwell<sup>1</sup>, D. C. Brown\*<sup>1</sup>, M. E. Davis<sup>1</sup>, Z. B. Johnson<sup>1</sup>, and T. M. Fakler<sup>2</sup>, <sup>1</sup>University of Arkansas, Fayetteville, <sup>2</sup>Zinpro Corp., Eden Prairie, MN.

Two experiments involving 276 pigs (19 ± 2 d of age; 6.2 kg BW) were conducted to determine the effect of copper source on performance of weanling pigs. Pigs in each experiment were blocked based on initial BW and penned in groups of two or three (8 pens/treatment) in a conventional nursery. Treatments (TRT) were: 1) a control diet containing all trace minerals from inorganic sources, 2) as 1 with 252 ppm Cu from CuSO<sub>4</sub>, 3, 4, and 5) as 1 with 100 ppm Cu from one of three batches of Availa<sup>®</sup> Cu copper amino acid complex (CuAA, Zinpro Corp), and 6) as 1 with 100 ppm Cu from CuPLEX<sup>®</sup> copper lysine (CuLys; Zinpro Corp.). All diets were fed in the pelleted form in three phases: d 0 to 10 (1.52% lys), 10 to 24 (1.35% lys), and 24 to 38 (1.15% lys). Dietary copper concentrations were maintained throughout the 38 d trial, and copper source replaced corn in the control diet. Performance responses did not differ due to batch, therefore data were grouped and reported as one treatment (TRT 3 = combined data for TRT 3, 4, 5) for contrasts. During d 0 to 10 postweaning, ADG, ADFI, and G:F for TRT 1, 2, 3 and 6 were 189, 214, 229, 226 g; 252, 274, 278, 283 g; and 0.72, 0.76, 0.82, 0.80, respectively. Copper supplementation, regardless of Cu source, resulted in improved (P < 0.05) ADG. Feed intake was greater (P < 0.05) in pigs receiving Cu from CuAA and CuLys than in those receiving the control diet. Gain:feed was improved (P < 0.01) in pigs fed CuAA when compared to those fed the control diet. For the overall study ADG, ADFI, and G:F for TRT 1, 2, 3, and 6 were 372, 398, 402, 396 g; 544, 571, 561, 560 g; and 0.68, 0.70, 0.72, 0.71, respectively. During the overall experiment, pigs fed CuSO<sub>4</sub> or CuAA had greater (P < 0.01) ADG and G:F than those fed the control diet. These data indicate that during the first 38-d postweaning, Cu supplementation from CuSO<sub>4</sub> or CuAA resulted in increases in ADG and G:F. One hundred parts per million Cu from CuLys or CuAA were as effective as 252 ppm Cu from CuSO<sub>4</sub> in improving gain during d 0 to 38 postweaning.

**Key Words:** Pigs, Copper source, Performance

**204 Copper complexes improve performance of weanling pigs.** T. M. Fakler\*<sup>1</sup>, C. J. Rapp<sup>1</sup>, and D. Fremaut<sup>2</sup>, <sup>1</sup>Zinpro Corp., Eden Prairie, MN, <sup>2</sup>Technical University of Gent, Belgium.

Copper sulfate (CuSO<sub>4</sub>) is routinely added to starter pig diets at levels 20 to 30 times the requirement to improve pig performance. A total of 413 pigs (28 d of age; 7.7 kg BW) were used to determine the effects of adding growth-promoting levels of Cu from CuSO<sub>4</sub> and two complexed Cu sources on pig performance. Pigs were divided across treatments on the basis of weight, gender and origin. Dietary treatments were: 1) control with no added Cu (Control); 2) control plus 160 ppm Cu from CuSO<sub>4</sub> (CuSO<sub>4</sub>); 3) control plus 160 ppm Cu from CuPLEX<sup>®</sup> copper lysine (CuLys) and 4) control plus 160 ppm Cu from Availa<sup>®</sup> Cu copper amino acid complex (CuAA). Body weight and feed intake were determined on d 14 and d 34. All animals were in very good health, therefore no medication was used throughout the entire study. Fecal quality and mortality were not affected by the treatment. From d 0 to 14 postweaning, adding Cu complexes (CuLys or CuAA) improved (P < .05) daily gain compared to pigs fed Control or CuSO<sub>4</sub> (296 and 304 vs 242 and 241 g respectively). Pigs fed CuLys consumed more (P < .05) feed than pigs fed Control (378 vs 308 g/d). Pigs fed CuAA converted feed better (P < .05) than pigs fed CuSO<sub>4</sub> (1.20 vs 1.52). For the overall 34-d experiment, pigs fed CuLys gained weight faster (P < .05) than pigs fed either Control or CuSO<sub>4</sub> (448 compared to 424 and 405 g/d) and the pigs fed CuAA gained weight faster (P < .05) than all other pigs (474 g/d). Pigs fed CuAA consumed more (P < .05) feed than pigs fed either Control and CuSO<sub>4</sub> (626 vs 573 and 586 g/d). In addition, pigs fed CuLys consumed more (P < .05) feed than Control pigs (612 vs 573 g/d). Pigs fed CuAA converted feed better (P < .05) than pigs fed either Control and CuSO<sub>4</sub> (1.29 vs 1.41 and 1.42). At the end of the 34-d study, pigs fed CuAA and CuLys were heavier (P < .05) than pigs fed either Control or CuSO<sub>4</sub>. The results of this study indicate that feeding complexed sources of Cu (CuLys or CuAA) to nursery pigs will yield heavier pigs at the end of the nursery while improving the feed:gain ratio during this critical phase of production.

**Key Words:** Pigs, Copper, Performance

**205 Efficacy of tetrabasic zinc chloride as a growth promoter for young pigs.** D. M. Webel\*<sup>1</sup>, I. Mavromichalis<sup>2</sup>, E. N. Parr<sup>1</sup>, and D. H. Baker<sup>2</sup>, <sup>1</sup>United Feeds, Inc., Sheridan, IN, <sup>2</sup>University of Illinois, Urbana.

Four experiments were conducted to determine the effects of feeding pharmacological concentrations of zinc (Zn) from either Waelz-processed zinc oxide (ZnO) or tetrabasic zinc chloride [i.e., TBZC, Zn<sub>5</sub>Cl<sub>2</sub>(OH)<sub>8</sub>] on nursery pig performance. In Exp. 1, 48 weaned pigs (5.4 kg) in four replicates were fed two levels of Zn (0 or 1,500 mg/kg) from either ZnO or TBZC without antimicrobial agents. Pigs receiving 1,500 mg Zn/kg from either ZnO or TBZC had greater (P < 0.05) gain and feed efficiency than controls. In Exp. 2, 144 weaned pigs (5.1 kg) were fed two levels of Zn (0 or 1,500 mg/kg) from either ZnO or TBZC in a 19-d growth assay. Each diet was fed to eight pens of six pigs, and all diets contained antimicrobial agents. No differences in weight gain were observed due to Zn supplementation, but feed efficiency was improved (P < 0.05) in pigs receiving 1,500 mg Zn/kg from TBZC. In Exp. 3, 150 weaned pigs (5.2 kg) received 0, 1,500 or 3,000 mg Zn/kg from either ZnO or TBZC in a 21-d growth assay involving no dietary antimicrobial agents. Weight gain responded quadratically (P < 0.06) to TBZC and linearly (P < 0.06) to ZnO addition, whereas feed efficiency responded only to TBZC (linear, P < 0.05). The gain response to TBZC at 1,500 mg Zn/kg was equal to the gain response to ZnO at 3,000 mg Zn/kg. In Exp. 4, 180 weaned pigs (4.5 kg) in five replicates received either no supplemental Zn, 3,000 mg Zn/kg from ZnO, or four incremental doses (750 to 3,000 mg Zn/kg) of TBZC in a 21-d growth assay, with all diets containing antimicrobial agents. Weight gain and feed efficiency were maximized when 1,500 mg Zn/kg from TBZC was fed, and responses (P < 0.05) to this supplement compared with the negative control were equal (P > 0.10) to the gain and feed efficiency responses (P < 0.05) produced from 3,000 mg Zn/kg supplementation from ZnO. These results indicate that TBZC is at least as effective as ZnO for growth promotion in young pigs, and 1,500 mg Zn/kg from TBZC is as efficacious as higher levels for achieving maximal growth responses.

**Key Words:** Nursery pigs, Zinc oxide, Tetrabasic zinc chloride

**206 Effect of feeding nursery pigs organic or inorganic sources of zinc on nutrient balance.** C. L. Case\* and M. S. Carlson<sup>1</sup>, University of Missouri-Columbia.

A 15-d balance study was conducted to evaluate the effect of feeding high concentrations of Zn, from organic and inorganic trace mineral sources, on plasma and tissue Zn accumulation, and Zn excretion of nursery pigs. Fifteen weaned, crossbred (GenetiPorc USA, LLC, Morris, MN) barrows (avg. 5.3 .006 kg and 17 d of age) were allotted to dietary treatments based on initial weight and ancestry. There were three replications per treatment in which one pig was placed per individual stainless steel metabolism cage. After a 10 d adaptation period to the cages and diet, feces and urine were collected for five, 24 h periods. A Phase 1 nursery diet was fed as crumbles through out the duration of the study (d 1 to 15). There were five dietary treatments: 150 ppm Zn as ZnO, 500 ppm Zn as ZnO, 500 ppm Zn as Availa-Zn 100 (amino acid complex), 500 ppm Zn as SQM-Zn (polysaccharide complex), and 3,000 ppm Zn as ZnO. Dietary treatment had no effect on fecal volume, but pigs fed 3,000 ppm Zn as ZnO had the greatest (P = .0001) volume/d of urine. Plasma, fecal, urinary, and liver Zn concentrations were greatest (P < .05) in pigs fed 3,000 ppm Zn as ZnO. Pigs fed 500 ppm Availa-Zn and 3,000 ppm ZnO had greater (P = .01) renal Zn concentration compared to pigs fed 150 ppm ZnO, 500 ppm ZnO or 500 ppm SQM-Zn. Pigs fed 150 ppm ZnO had the least amount of Zn in the feces; ZnO, Availa-Zn, and SQM-Zn at 500 ppm Zn were similar and intermediate compared to pigs fed 3,000 ppm ZnO that had the greatest fecal Zn concentration (136, 537, 448, 508, and 2,157 mg/d, respectively). On d 10-15, the Zn balance of pigs was negative for all dietary treatments (-10.5, -44.9, -34.2, -30.8, and -109 mg/d, respectively). In conclusion, it appears that organic Zn sources do minimize nutrient excretion by approximately 27% compared to inorganic Zn fed at the same dietary concentration. The major factor affecting nutrient excretion appears to be dietary concentration, independent of source.

**Key Words:** Nursery pigs, Zinc, Balance

**207 Pharmacological additions of zinc to nursery diets and subsequent skeletal integrity in finishing gilts.** T.D. Crenshaw\* and D.K. Schneider, *University of Wisconsin, Madison, WI.*

Addition of Zn (3000 ppm, +Zn) from ZnO to nursery diets increases growth and bone Zn content, but may compromise skeletal integrity (J.Anim.Sci. 77:178). Zn toxicosis is altered by dietary Ca concentrations. The current objective was to determine if nursery pigs fed +Zn had compromised skeletal integrity at market weight. Eighty gilts were weaned (23 d, 6.1 kg) and randomly allotted to one of four diets arranged as a 2 x 2 factorial with Ca (+Ca, 1.0%; -Ca, 0.60%) and Zn (-Zn, 124 ppm; +Zn, 3,124 ppm) levels during the nursery period. In subsequent diets differences were maintained in Ca and P (+Ca, -Ca), but dietary Zn levels were constant. +Zn did not improve ( $P > 0.10$ ) growth in nursery nor subsequent periods (8, 12 and 20 wk postweaning). Pigs fed +Ca gained more ( $P < 0.01$ ) than pigs fed -Ca at each interval, most likely due to differences in dietary P. No Ca x Zn interactions were detected in growth or feed efficiency. +Zn increased femur and metatarsal cortical area and mid-shaft diameters at 8 wk post-weaning in +Ca groups, but reduced responses in the -Ca groups (Ca x Zn interaction,  $P < .05$ ). Effects of +Zn on bone morphology induced in nursery pigs, were corrected by 12 wk post-weaning as no differences were detected at wk 12 and 20. +Zn tended ( $P < .06$ ) to increase bone bending moment and stress at 8 wk, but responses were not different at wk 12 and 20. At 8 wk bone ash Zn content was greater ( $P < .001$ ) in pigs fed +Zn, but differences decreased with age. By wk 20 no differences in bone Zn were detected in pigs fed +Ca, but bones had 10% more Zn in -Ca,+Zn pigs than -Ca,-Zn pigs. Cu and Fe content in bone ash was not affected by dietary Zn, but bone Mn was higher in pigs fed +Zn. Expected differences due to dietary Ca and P levels were detected in bone morphology and mechanical properties. Pharmacological additions of Zn to nursery diets did not compromise skeleton integrity in market-weight gilts.

**Key Words:** Zinc, Calcium, Pig

**208 The effects of supplementing zinc and soybean oil to the diets of weanling pigs on growth performance.** C. R. Dove\*, *University of Georgia, Tifton, GA.*

One hundred and eighty crossbred [(Yorkshire Hampshire) Premier T-Max] pigs were used in a study to determine the effect of added dietary zinc and soybean oil on growth performance and feed efficiency of weanling pigs. Pigs averaged 24 d of age and 7.3 kg initially and were randomly allotted by weight, sex, and ancestry, at weaning to experimental diets. Pigs were housed in an environmentally controlled nursery, and had ad libitum access to feed and water throughout the 28-d study. Dietary treatments were arranged in a 2 x 3 factorial for the first 14 d (Phase 1) of the study. Dietary treatments were either 200 or 3000 ppm supplemental Zn and either 0, 2.5, or 5% soybean oil. During d 14 to 28 (Phase 2) of the study, pigs remained on their respective soybean oil treatments, but all pigs receive 200 ppm supplemental Zn. The addition of 3000 ppm Zn during Phase 1 increased ( $P < 0.01$ ) ADG, ADFI and improved feed efficiency. The addition of soybean oil to the diet had no effect ( $P > 0.1$ ) on ADG or ADFI, but did improve ( $P < 0.05$ ) feed efficiency during Phase 1 of the study. However, ADG and feed efficiency were decreased ( $P < 0.05$ ) during Phase 2 of the study in those pigs that were fed 3000 ppm dietary Zn during Phase 1 of the study. The addition of soybean oil had no effect ( $P > 0.1$ ) on growth performance or feed efficiency during Phase 2. Over the entire 28 d study, the addition of 3000 ppm Zn to the diet during Phase 1 of the study increased ADG ( $P < 0.05$ ), but had no effect on ADFI or feed efficiency ( $P > 0.1$ ). The addition of dietary soybean oil had no effect ( $P > 0.1$ ) on growth performance or feed efficiency over the 28 d study. No Zn soybean oil interaction was observed at any time during the study. These data indicate that the addition of 3000 ppm Zn to the diets of nursery pigs will improve pig performance, while the addition of soybean oil to the diets of nursery pigs has little effect on performance over entire nursery period. These data also indicate that supplemental Zn may be needed by the nursery pig for a period longer than the first 14 d postweaning.

**Key Words:** Pigs, Zinc, Soybean oil

**209 Efficacy of mannan oligosaccharide (Bio-Mos®) as a complete or partial replacement for zinc oxide in the diets of weanling pigs.** M. E. Davis\*<sup>1</sup>, D. C. Brown<sup>1</sup>, C. V. Maxwell<sup>1</sup>, Z. B. Johnson<sup>1</sup>, and R. A. Dvorak<sup>2</sup>, <sup>1</sup>*University of Arkansas, Fayetteville,* <sup>2</sup>*Alltech, Nicholasville, KY.*

A total of 216 weanling barrows (The Pork Group, Inc.;  $21 \pm 2$  d of age; 5.5 kg BW) were fed one of six dietary treatments to determine the potential of Bio-Mos® (BM) to serve as a complete or partial replacement for pharmacological addition of ZnO. Pigs were blocked by BW and penned in groups of six (6 pens/treatment) in an off-site nursery. Treatments were arranged as a 2x3 factorial with 0 or 0.3% BM and 165, 500, or 2465 ppm Zn. Experimental diets were fed throughout the study and contained 1.5% Lys during phase 1 (d 0 to 7), 1.35% Lys during phase 2 (d 7 to 21), and 1.2% Lys during phase 3 (d 21 to 35). Zinc was maintained at 165 ppm in treatment diets during phase 3. Two pigs/pen were bled via venipuncture during the first week of phase 3 and a lymphocyte blastogenesis assay was performed. There was no ADG, ADFI, or gain:feed (G/F) response to BM or Zn supplementation during phase 1. During phase 2, ADG was greater ( $P \leq 0.05$ ) when pigs were fed diets containing 2465 ppm Zn compared to pigs fed diets containing 165 and 500 ppm Zn. Pigs fed 2465 ppm Zn had greater ( $P \leq 0.05$ ) ADFI than pigs fed 165 ppm Zn and greater ( $P \leq 0.05$ ) G/F than pigs fed 500 ppm Zn. Bio-Mos® improved ( $P \leq 0.05$ ) ADG and G/F during the first week of phase 3 (d 21 to 28), and G/F in the overall experiment (d 0 to 35). Lymphocyte proliferation of cell cultures unstimulated by mitogen was less ( $P \leq 0.05$ ) in cells isolated from pigs fed BM than in pigs fed diets devoid of BM. A BM x Zn interaction ( $P \leq 0.05$ ) was observed for lymphocyte proliferation response of cultures stimulated by pokeweed mitogen and phytohemagglutinin, in which proliferation decreased when Zn was supplemented to diets without BM, but increased when Zn was added to diets containing BM. The results of this study indicate that BM improves ADG from d 21 to 28 postweaning, and improves G/F during phase 2, phase 3, and the overall nursery period. Additionally, BM acts to modulate in vitro lymphocyte response in nursery pigs.

**Key Words:** Swine, Oligosaccharide, Zinc

**210 Efficacy of brewers dried yeast as a source of mannanoligosaccharides, without and with organic acids, and of carbadox on performance and intestinal bacterial populations of weanling pigs.** L. A. White\*, M. C. Newman, G. L. Cromwell, and M. D. Lindemann, *University of Kentucky, Lexington, KY.*

Brewers dried yeast, as a source of mannanoligosaccharides (MOS), was assessed as an alternative to an antimicrobial agent (carbadox) for young pigs. Seven pen-replicates of 22-d-old pigs ( $n = 140$ , five pigs/pen) were fed four diets: non-medicated basal diet, carbadox (55 mg/kg), MOS (3% yeast), and MOS+organic acid (3% yeast, 2% citric acid) for 28 d, from 6.6 to 18.0 kg. The basal diet (1.4% Lys for 2 wk, then 1.2% Lys) was corn-soy-dried whey-dried plasma/cells. Feces were collected from all pigs at 2 and 4 wk for pH, VFA concentrations, and enumeration of microbial populations. Three pigs/pen were bled at 4 wk for immunoglobulin quantification, and one pig/pen was killed at 4 wk for gut morphology. Agglutination tests indicated that MOS was effective in binding *E. coli* and *Salmonella* spp. In this experiment, neither carbadox, MOS, nor MOS+acid improved growth rate (431, 418, 393, 391 g/d), feed intake (709, 671, 633, 636 g/d), or feed:gain (1.64, 1.60, 1.62, 1.63, respectively). Pigs fed carbadox gained faster and consumed more feed than those fed MOS or MOS+acid ( $P < .05$ ). Log counts (CFU/g) of total coliforms (6.3, 6.1, 6.1, 6.5), *E. coli* (3.7, 4.5, 3.8, 3.3), and *Clostridium perfringens* (2.9, 2.7, 2.6, 2.8) at 4 wk were not affected ( $P = .20$ ) by diet, but both *Bifidobacteria* spp. and lactobacilli counts were greater ( $P < .05$ ) in pigs fed MOS vs carbadox (8.9, 8.7, 9.2, 8.4; 9.0, 8.9, 9.3, 8.9). Fecal pH at 4 wk was not affected by diet (5.9, 6.0, 5.9, and 6.1). Fecal isobutyrate, valerate, and isovalerate at 4 wk tended to be greater in controls (5.9, 4.8, 5.0, 4.6; 9.8, 6.2, 8.0, 7.8; 6.0, 5.3, 5.2, 4.1 M/g), but other VFAs were not affected. In this study, neither carbadox nor brewers dried yeast (as a source of MOS) without or with organic acid enhanced performance, and their effects on the gut microbial populations and other measurements were minimal.

**Key Words:** Pigs, Yeast, Carbadox

**211 Comparative effects of mannanoligosaccharide and an antibiotic in nursery diets on performance of pigs reared on three different farms.** D. W. Rozeboom\*<sup>1</sup>, D. T. Shaw<sup>1</sup>, J. E. Pettigrew<sup>2</sup>, and A. Connolly<sup>3</sup>, <sup>1</sup>Michigan State University, East Lansing, <sup>2</sup>Pettigrew Consulting International, LCC, Louisiana, MO, <sup>3</sup>AllTech, Inc., Nicholasville, KY.

The objective of this experiment was to compare the effects of dietary mannanoligosaccharide (MOS) and a feed-grade antibiotic on growth performance of pigs reared in three different, multiple-room nursery facilities. Two of the nurseries (A and B) were located on large-scale commercial farms. The third nursery (C) was located at Michigan State University. Nurseries were operated "continuous flow" by building, but "all-in/all-out" by room. Within each nursery, all pigs were in one room. Pigs (A, n = 771, 18.4 d weaning age; B, n = 576, 19.0 d weaning age; C, n = 96, 20.6 d weaning age) were blocked (within nursery) by weight and sex, and randomly allotted to dietary treatments, which were arranged in a 2 x 2 factorial design. The two factors were (1) with and without MOS (0.3% in phase 1, 0.2% in phases 2, 3, and 4; Bio-Mos<sup>TM</sup>) and (2) with and without antibiotic (110 mg tylosin and 110 mg sulfamethazine per kg of diet in all phases; Tylan<sup>®</sup> 40 Sulfa-G<sup>TM</sup>). The four nursery phases were 4, 7, 14, and 17 d, respectively. Other nutrients were at or slightly above concentrations suggested by NRC (1998). With 35, 20, and 4 pigs per pen in nurseries A, B, and C, respectively, space allowance per pig was 0.29, 0.26, and 0.56 m<sup>2</sup>. Across all nurseries, ADG for the entire 42-d experiment was improved (P < .05) with the addition of MOS or antibiotic (368, 394, 406, and 410 g/d, for control, MOS, antibiotic, and MOS plus antibiotic, respectively). Performance differed depending on nursery facility (P < .01). There were no growth improvements with MOS in nurseries A and B. Antibiotic improved (P < .05) ADG in nursery A. Pigs in nursery C fed either MOS or antibiotic had greater ADG, ADFI, and G/F than controls (P < .05). The results of this study suggest that MOS may be an alternative to tylosin and sulfamethazine as a growth promotant in nursery diets.

**Key Words:** Swine, Mannanoligosaccharide, Antibiotic

**212 Effect of *Quillaja saponaria* extract on weanling pig growth performance and immune function during acute enteric disease challenge.** J.L. Turner\*<sup>1</sup>, S.S. Dritz<sup>1</sup>, J.R. Werner<sup>1</sup>, C.M. Hill<sup>1</sup>, K. Skjolaas<sup>1</sup>, K. Herkelman<sup>2</sup>, and J.E. Minton<sup>1</sup>, <sup>1</sup>Kansas State University, Manhattan KS, <sup>2</sup>Farmland Industries, Inc., Kansas City MO.

*Quillaja saponaria* (QS) extract has been in vaccine adjuvants for three decades. The saponin fraction of the extract can inhibit *E. coli* growth. We investigated the effect of dietary QS extract (without added antibiotics) on growth and immune function of nursery pigs challenged with *Salmonella typhimurium* (STC). A total of 96 pigs (8.6 kg) were assigned to eight treatments in a 2 x 4 factorial with main effects of disease challenge (control vs. STC) and dietary treatment (0, 125, 250, or 500 mg/kg added QS). ADG, ADFI, and G/F were determined on d 7, 14, 21, and 28 of the trial. On d 14, 48 pigs were infected orally with *S. typhimurium*. Daily feed intake (DFI) and rectal temperature (RT) were monitored for 7 d following STC. On d 0, 7, and 14 after STC, serum was analyzed for haptoglobin (HAPT) and  $\alpha_1$ -acid glycoprotein (AGP). On d 0, 2, 4, and 6 post-challenge, serum IGF-I levels were determined. There were no differences (P > .05) in ADG, ADFI, G/F, DFI, RT, IGF-I, HAPT, or AGP between QS treatments. A STC by time interaction (P < .05) was observed for ADG, ADFI, G/F, DFI, RT, IGF-I, HAPT, and AGP. Prior to STC, ADG, ADFI, and G/F were similar between controls and STC-pigs. STC depressed (P < .05) ADG (0.7 vs. 0.41 kg/d), ADFI (1.05 vs. 0.78 kg/d), and G/F (0.67 vs. 0.51) in the wk following STC; however, ADG returned to control levels by wk 4. DFI was lower (P < .05) on d 2 to 5 following STC, and RT was increased (P < .05) on d 1, 2, 3, 4, and 6 post-challenge for STC-pigs. HAPT was elevated (P < .05) on d 7 post-challenge and AGP was higher (P < .05) on d 7 and 14 in STC-pigs. STC depressed (P < .05) IGF-I on d 2, 4, and 6 following STC. We conclude that this model of enteric disease invokes an acute phase response accompanied by a depression in circulating IGF-I. It appears that dietary inclusion of QS extract, at the levels reported herein, offers little benefit to growth performance or immune function in pigs undergoing an enteric disease challenge.

**Key Words:** Swine disease, IGF-I, Acute phase response

**213 Effect of seaweed extract on weanling pig growth performance and immune function during acute enteric disease challenge.** J.L. Turner\*, S.S. Dritz, J.R. Werner, C.M. Hill, K. Skjolaas, and J.E. Minton, Kansas State University, Manhattan KS.

Extracts of seaweed plants have been shown to have antitumor effects in rodents. More recently the extract of the seaweed *Ascophyllum nodosum* (ANOD) has shown beneficial effects on fescue toxicosis in beef cattle. We investigated the effect of dietary ANOD (without added antibiotics) on growth and immune function of nursery pigs in the presence of *Salmonella typhimurium* challenge (STC). Pigs (6.8 kg) were blocked by weight and assigned randomly to one of eight treatments (two pigs per pen; six pens per treatment) in a 2 x 4 factorial with main effects of disease challenge (control vs. STC) and dietary treatment (0, 0.5, 1.0, or 2.0 % added ANOD). ADG, ADFI, and G/F were determined on d 7, 14, 21, and 28 of the trial. On d 14, 48 pigs were infected orally with *S. typhimurium*. During the 7 d following STC, daily feed intake (DFI) and rectal temperature (RT) were monitored. On d 0, 7, and 14 with respect to STC, serum was analyzed for haptoglobin (HAPT) and  $\alpha_1$ -acid glycoprotein (AGP). There were no differences (P > .05) in ADG, ADFI, G/F, DFI, RT, HAPT, or AGP between ANOD treatments. A STC by time interaction (P < .05) was observed for ADG, ADFI, G/F, DFI, RT, HAPT, and AGP. Prior to STC, ADG, ADFI, and G/F were similar between controls and STC-pigs. STC depressed (P < .05) ADG (0.63 vs. 0.43 kg/d), ADFI (0.87 vs. 0.74 kg/d), and G/F (0.73 vs. 0.58) in the wk following STC; however, growth performance returned to control levels by wk 4. DFI was lower (P < .05) on d 2 to 4 following STC, and RT was higher (P < .05) on d 0 to 3 post-challenge for STC-pigs. HAPT declined over time in controls, while HAPT for STC-pigs were elevated (P < .05) on d 7 post-challenge. AGP was higher (P < .05) on d 7 and 14 post-challenge for STC-pigs compared to controls. In a companion study, culture of porcine alveolar macrophages with 10 mg/mL ANOD extract for 24 hr increased (P < .05) PGE<sub>2</sub> synthesis, but not tumor necrosis factor alpha. We conclude that this model of enteric disease is effective in eliciting an acute phase response. However, ANOD extract appears to offer little benefit to growth performance or immune function of nursery pigs in the presence or absence of STC.

**Key Words:** Swine disease, Seaweed, Immunity

**214 Effect of Solutein<sup>TM</sup> (Sol) on rate and efficiency of body weight gain in weaned pigs.** M.M. Ward\* and D.R. Cook, Akey, Inc., Lewisburg, OH.

Four nursery trials utilizing 880, 880, 285 and 127 pigs weaned at 16 to 19 d of age, were conducted to determine the effect of Sol on growth performance. Sol is a water soluble product including spray-dried animal plasma and serum, serum globulin, lactose, citric acid, fructo-oligosaccharide, KCl, and DL-methionine. At weaning, pigs were transported 13h, randomly allotted (22/pen, 0.25 m<sup>2</sup>/pig) to treatments based on body weight within gender, and given ad libitum access to dry pelleted feed, and water with or without Sol. In Exp. 1 (4.8 kg BW), Sol was administered through the water at 2.5% (wt/vol) up to d 4 and at 1.25% (wt/vol) from d 5 to 8 post-weaning. Pigs administered Sol from d 1 to 5 had greater ADG (124 vs 197 g, P < .01), higher ADFI (151 vs 182 g, P < .01), and improved feed:gain (1.65 vs 0.94, P < .03) vs control pigs. There were no differences (P > .10) in growth performance from d 6 to 14, however, administration of Sol for 8 d decreased pigs removed (P < .01) from test (9.5% vs 2.1%) vs the control. In Exp. 2 (5.0 kg BW), Sol was administered through the water for 0, 2, 4 or 8 d at 2.5% (wt/vol) from d 1 to 4 and 1.25% (wt/vol) from d 5 to 8 post-weaning. Pigs receiving Sol for 4 or 8 d had greater ADG (176, 188 vs 142, 129 g, P < .09) and improved feed:gain (0.95, 0.93 vs 1.16, 1.13, P < .03) vs pigs fed Sol for 0 or 2 d. Pigs fed no Sol had the highest percent mortality (P < .01). Over the 45 d trial, pigs administered Sol for 8 d were 0.73 kg heavier than control pigs (P < .05). In Exp. 3 (4.0 kg BW) and 4 (3.6 kg BW), Sol was added at 454 g/pen/d for 7 d (Exp. 3), or 227 g/pen/d for 3 d followed by 114 g/pen/d for 4 d (Exp. 4) with 40% water and 30% pelleted feed in a gruel feeder. Control pigs received gruel feed with no Sol. Dry pelleted feed and water were also offered ad-libitum. There was no difference (P > .10) in growth performance 7 d post-weaning between pigs fed Sol in gruel feed vs control pigs. In conclusion, administration of Sol for an initial 8 d post-weaning via water, but not gruel, improves growth performance throughout the nursery.

**Key Words:** Pigs, Plasma, Growth

**215 Efficacy of biopeptides and blood plasma with young pigs during the starter period.** T.G. Wiseman\*<sup>1</sup>, D.C. Mahan<sup>1</sup>, B. Harmon<sup>2</sup>, and N. Trottier<sup>3</sup>, <sup>1</sup>The Ohio State University, <sup>2</sup>Purdue University, <sup>3</sup>Michigan State University.

Weaning pigs at younger ages has been successful due to the development of dietary proteins that are easily digested and stimulate feed intake. Continual efforts are being made to develop products that will maintain growth performance yet lower starter feed costs. In this study a biopeptide, Ultimate Protein (UP 1672), that contains a blend of plant/yeast products was evaluated at 4 dietary substitution levels for blood plasma protein. Trials were conducted jointly at Michigan State, Ohio State, and Purdue Universities, using a total of 344 pigs that were weaned at an average of 5.6 kg BW. Pigs were weaned from 14 to 21 d of age and allotted to a RCB designed experiment conducted in 16 replicates. Total dietary blood plasma protein levels were set at 6.0, 3.0 and 0.0% for each phase period. The biopeptide replaced plasma protein in phase 1 and 2 on a lysine basis, with all groups receiving a common diet for phase 3. Diets were provided ad libitum for a 38 d trial period which consisted of 3 phases of 10, 14 and 14 d, where dietary lysine levels of 1.60, 1.45 and 1.30% were provided, respectively. Performance data were collected on d 10, 24 and 38, with each station conducting a minimum of 5 replicates. Overall treatment effects during the 0 to 10 d period demonstrated an increase (linear,  $P < 0.01$ ) in daily gain and feed intake as dietary level of blood plasma protein increased. Treatment responses during the 10 to 24 d period were similar for all treatment groups. For the 24 to 38 and 0 to 38 d periods daily gains, feed intake and feed efficiencies were similar. These results indicate that during the phase 1 period, pig performance to the addition of blood plasma was superior to the biopeptide, but for the 10 to 24 d period the biopeptide was as equally effective. For the overall 38 d period performance responses were similar for all groups.

**Key Words:** Weanling pig, Protein

**216 Comparison of spray-dried blood meal and blood cells in diets for nursery pigs.** J.M. DeRouchey\*, J.L. Nelssen, M.D. Tokach, R.D. Goodband, S.S. Dritz, J.C. Woodworth, and B.W. James, Kansas State University, Manhattan.

Two experiments were conducted to determine lysine bioavailability and the effect of increasing levels of spray-dried blood meal (BM) and blood cells (BC) in nursery pig diets. In Exp 1, 350 pigs (6.2 kg and  $17 \pm 2$  d) were used in a 19-d growth assay. All pigs were fed the same pelleted SEW diet to 5 d after weaning. Then, pigs were fed one of seven experimental diets, which included a control with no blood products, and diets containing either 2.5, 5.0, or 7.5% BM or BC. The blood products replaced soybean meal in the diet on a lysine basis. Treatment diets were fed in meal form and formulated to contain 1.40% lysine, .090 Ca, 0.54 available P, 0.26 Na, and 0.43 Cl. For Exp 2, 350 pigs (10.7 kg) were used in a 21-d growth assay to determine the lysine bioavailability of BM, BC and L-Lysine HCl. Diets included both a negative (0.95% lysine) and positive (1.40% lysine) control with no blood products or L-Lysine HCl. Treatment diets were formulated to increase the lysine level in the negative control diet by 0.15% increments (1.10, 1.25, 1.40%) through the addition of L-Lysine HCl, BM, or BC replacing corn starch. Corn and soybean meal were held constant in all diets except the positive control. All diets were formulated to equal energy, Na, and Cl. Crystalline amino acids were added in diets of both experiments to maintain similar ratios of amino acids relative to lysine and above NRC (1998) ratios. In Exp 1, pigs had improved ADG ( $P < .005$ ) and gain/feed ( $P < .001$ ) when blood products were included into the diet. Pigs fed BM tended ( $P < .09$ ) to have greater ADFI than those fed BC; however, no differences in ADG or G/F existed ( $P > .24$ ). As BM increased in the diet, G/F ( $P < .04$ ) and ADG ( $P < .10$ ) improved linearly, while BC did not affect growth performance. In Exp 2, lysine bioavailability was determined by slope-ratio of the efficiency of gain. The lysine bioavailability of BM and BC was 103 and 102%, respectively, relative to the bioavailability of L-Lysine HCl.

**Key Words:** Pig, Blood meal, Blood cells

**217 Irradiation reduces the bacteria in animal plasma and improves growth performance of nursery pigs.** J.M. DeRouchey\*, J.L. Nelssen, M.D. Tokach, R.D. Goodband, S.S. Dritz, B.W. James, and M.J. Webster, Kansas State University, Manhattan.

One hundred eighty pigs (BW of 5.9 kg and  $17 \pm 2$ ) were used in a 24 d growth assay to determine the effects of source, drying technique,

and irradiation of animal plasma. Treatment diets were fed in meal form from d 0 to 10 with a control diet containing no animal plasma and five additional diets containing 5% animal plasma from two different sources. From source 1 (S1), treatment diets were animal plasma that had been spray-dried, spray-dried then irradiated, or freeze dried then irradiated. From source 2 (S2), treatment diets consisted of animal plasma that had been spray-dried or spray-dried then irradiated. All treatment diets were formulated to contain 1.50% lysine, 0.89 Ca, and 0.54 available P. A common Phase II diet was fed from d 10 to 24. Irradiation reduced bacteria levels in plasma from  $10^4$  to less than  $10^2$  CFU/g. From d 0 to 5, pigs fed irradiated plasma had increased ADG ( $P < .05$ ) and ADFI ( $P < .10$ ) compared to those fed regular plasma, regardless of source. Pigs fed S2 nonirradiated plasma had improved ADG and G/F ( $P < .05$ ) compared to those fed the control diet, whereas those fed S1 plasma did not. From d 0 to 10, ADG (297 vs 252 g [S1]; 330 vs 295 g [S2],  $P < .05$ ) and ADFI (325 vs 293 g [S1]; 363 vs 328 g [S2],  $P < .10$ ) was greater for pigs fed irradiated plasma versus plasma that had not been irradiated. Freeze drying plasma did not improve growth performance compared with spray-drying, indicating that protein damage from spray-drying was not a concern. From d 10 to 24, ADFI was improved ( $P < .05$ ) for pigs previously fed diets containing animal plasma that was irradiated versus plasma that was not irradiated. Pigs fed irradiated spray-dried plasma were heavier (14.2 [S1] and 14.2 kg [S2],  $P < .05$ ) at d 24 compared to control pigs (12.7 kg), whereas pigs fed regular spray-dried plasma were not. These results indicate that irradiation reduces bacteria in animal plasma and improves growth performance of nursery pigs.

**Key Words:** Pig, Plasma, Irradiation

**218 The effects of pH and irradiation of spray-dried blood meal on nursery pig performance.** J.M. DeRouchey\*, M.D. Tokach, J.L. Nelssen, R.D. Goodband, S.S. Dritz, J.C. Woodworth, B.W. James, M.J. Webster, and D.E. Real, Kansas State University, Manhattan.

A decrease in blood meal (BM) pH and increase in bacterial levels are believed to be caused from increased storage time prior to spray-drying. One hundred fifty pigs (BW of 6.3 kg and  $17 \pm 2$  d of age) were used in a 19-d growth assay to determine the effects of pH and irradiation of BM on nursery pig performance. All pigs were fed experimental diets, which included a control diet with no added BM and 5 diets containing 5.0% BM. The five BM treatments were spray-dried from the same lot of blood. One fourth of the lot was dried on d 0, 3, 8, or 12 after collection. This resulted in four BM treatments with pH values of 7.6, 6.4, 6.0, and 5.9 respectively. The fifth treatment was irradiation of the BM with a pH of 5.9. Treatment diets were fed in meal form and formulated to contain 1.40% lysine, 0.90 Ca, and 0.54 available P. The concentration of bacteria increased with storage time until d 8, and then decreased slightly at d 12 of spray-drying. For d 0 to 14 of the experiment (d 5 to 19 postweaning), feed efficiency (G/F) was improved ( $P < .004$ ) without affecting ADG and ADFI when BM (nonirradiated) was added to the diet compared to the control pigs. The pH of the BM did not influence growth performance. Irradiation of the BM with a pH of 5.9 improved ( $P < .02$ ) ADG and G/F. Irradiation of BM reduced the level of the bacteria in the BM. These results indicate that pH of spray-dried BM decreases with increased storage time prior to spray-drying, however, this does not influence nursery pig performance. Also, irradiation is effective in reducing bacteria concentrations and improving nursery pig performance.

Item	Blood Meal pH						SE
	Control	7.6	6.9	6.0	5.9	Irradiated 5.9	
ADG, g	213	245	232	245	227	281	17
ADFI, g	354	359	345	350	327	363	16
G/F, g/kg	602	682	672	700	694	774	27
TPC,	-	3.7 x	1.1 x	1.2 x	6.6 x	9.0 x	
CFU/g	-	$10^6$	$10^7$	$10^7$	$10^6$	$10^1$	

**Key Words:** Pig, Blood meal, Irradiation

**219 Spray dried eggs as an ingredient in diets for SEW pigs.** S.E. Norberg\*, J.B. Durst, M.A. Latour, and B.G. Harmon, *Purdue University West Lafayette, IN.*

Three hundred and eight pigs weaned from 14 to 18 days of age were used to study the value of spray dried eggs (SDE) in segregated early weaning programs. SDE are rich in protein (51%), lysine (3.98%), and fat (31.1%), all on a dry matter basis. In all studies, SDE were used as a partial or complete replacement for porcine plasma protein (PPP). In Study 1, SDE were substituted at 0, 1/3, 2/3, and 3/3 of PPP on an equal protein basis, when PPP was fed at 7% in Phase 1 (10 days) and 3.5% in Phase 2 (14 days). In Study 2, during Phase 1 (10 days) SDE were fed at 0, 6, 12 and 18% of the diet and PPP was added only in the SDE void diet. During Phase 2 (14 days), the inclusion of SDE and PPP was reduced by 50%. In both studies, during Phase 3 (14 days), a common diet was fed in which SDE and PPP were removed from the diet. During Phase 1 of study 1, daily gain (ADG), intake and feed:gain (F:G), were 136, 137, 118, 100 g; 236, 227, 222, 177 g; 1.72, 1.66, 1.88, 1.77. ADG was greater ( $P < 0.05$ ) when 0 and 1/3 of the PPP were replaced with SDE. F:G was not significantly ( $P < 0.05$ ) different across treatments. In Phase 2, ADG and F:G were: 399, 363, 354, 359 g; 1.61, 1.65, 1.64, 1.57. ADG was significantly ( $P < 0.05$ ) greater when PPP composed all of the specialized ingredients. ADG and F:G were similar in Phase 3. In Study 2 (phase 1), ADG, intake, and F:G were 303, 281, 271, 270 g; 355, 332, 321, 335 g; 1.16, 1.18, 1.18, 1.24. During Phase 2 of the second study, ADG and F:G were 565, 524, 518, 514 g; 1.37, 1.41, 1.39, 1.45. ADG was significantly ( $P < 0.05$ ) greater for the pigs receiving PPP than for the diets containing SDE in phases 1 and 2. There were no differences in ADG, feed intake or F:G during the third phase of the trial. In the 2 studies, SEW pigs gained more rapidly during the initial 10 days post weaning when receiving PPP than when receiving SDE in the starter diets, but F:G values were similar. For the entire 38-day studies, there were no differences among the treatments.

**Key Words:** Pigs, Spray-dried eggs, Porcine plasma protein

**220 Evaluation of triticale and soft red wheat in nursery diets for pigs weaned at three weeks of age.** R. O. Myer, *University of Florida, Gainesville.*

A study was conducted to evaluate postweaning growth performance of early weaned pigs when triticale (Trit) or soft red winter wheat (SRW) replaced corn in diets fed during the nursery phase (3 to 8 wk of age). Five feeding trials were conducted - three involving Trit vs corn (1-3) and two involving SRW vs corn (4, 5). Trial 1 used 90 pigs (6.7 kg avg. initial wt; 6 reps), trial 2 - 84 pigs (7.0 kg; 6 reps), trial 3 - 150 pigs (6.5 kg; 10 reps), trial 4 - 154 pigs (6.5 kg; 10 reps), and trial 5 - 82 pigs (7.2 kg; 6 reps). Immediately after weaning (20 d), the pigs were fed nutritionally adequate, isolysine diets containing either corn or Trit, or corn or SRW as the grain source. The Trit and SRW analyzed (as fed) respectively, 11.8 and 12.9% CP, 4.4 and 4.4% ADF, 13.4 and 11.4% NDF, and 0.40 and 0.41% lys. A two phase nursery diet scheme was used - complex phase I diets from 0 to 12 d postweaning (1.5% lys, 3.3 mcg ME/kg; 54% grain in diets), and less complex phase II from 12 to 35 d (1.4% lys, 3.4 mcg ME/kg; 64% grain). The substitution of Trit or SRW for corn resulted in similar ( $P > 0.10$ ; trials 1 and 4) or slightly better ( $P < 0.10$ ; trials 2, 3 and 5) ADG over the 35 d nursery period. The improvements were from improvements during phase II; ADG were similar ( $P > 0.10$ ) during phase I in all trials. For the three Trit trials combined (22 reps), pigs fed the Trit diets had a slightly greater overall ADG than pigs fed the corn diets (0.51 vs. 0.49 kg;  $P < 0.05$ ); F/G was similar (1.58 vs. 1.58;  $P > 0.10$ ). Over both SRW trials (16 reps), pigs fed the SRW diets also had a slightly greater overall ADG than pigs fed the corn diets (0.52 vs. 0.51;  $P < 0.10$ ); F/G was slightly better (1.46 vs. 1.54;  $P < 0.10$ ). These results indicate that Trit and SRW are suitable feed grains for nursery diets for three wk old weaned pigs.

**Key Words:** Pigs, Triticale, Soft red winter wheat

**221 Effect of dietary carbohydrate or soybean oil on postweaning pig performance, serum triglyceride, urea nitrogen, and body composition.** S. Ching\* and D.C. Mahan, *The Ohio State University, Columbus.*

Both dietary fat and carbohydrate (lactose) have improved the growth performance of weaning pigs, but the effect of dietary levels of carbohydrate and fat in combination on postweaning pig performance has not

been studied. A 33 factorial arrangement of treatments was conducted in a randomized complete block (RCB) design where 3 levels of dietary lactose (0, 20, 40%) and 3 levels of soybean oil (0, 5, 10%) were evaluated in 9 replicates. The trial used a total of 342 crossbred pigs weaned at an average 17 d of age and 6.2 kg BW. Pigs were fed corn-SBM diets with the lysine to metabolizable energy (ME) ratio maintained during the feeding period for all treatment groups. Pigs were bled at 14 and 35-d postweaning with serum analyzed for triglyceride and urea N. Three pigs per treatment group were killed at d 35 for whole body composition. The results showed that dietary lactose improved daily gains during the 0 to 14-d ( $P < 0.05$ ) and 15 to 35-d ( $P < 0.01$ ) periods. Dietary fat improved daily gains during the 0 to 14-d period ( $P < 0.05$ ). Daily feed intake was higher when dietary lactose ( $P < 0.01$ ) and lower when dietary fat ( $P < 0.01$ ) was fed during the 0 to 35-d period. Gain to feed ratio ( $P < 0.01$ ) improved during both the 0 to 14- and 15 to 35-d periods when dietary fat level increased. Serum triglyceride increased as dietary fat levels increased, whereas serum urea N declined ( $P < 0.01$ ) as dietary fat levels increased at both 14 and 35-d. An interaction ( $P < 0.05$ ) occurred between dietary fat and lactose in serum urea N levels at d 35. As dietary fat levels increased, total body fat ( $P < 0.01$ ) and total body protein ( $P < 0.01$ ) increased. The results indicated that both dietary lactose and fat have a mutually beneficial effect on pig growth performance during the postweaning period.

**Key Words:** Lactose, Soybean oil, Weaning pig

**222 Stickwater as a fat source in diets for nursery pigs.** C. L. Jones\*, J. D. Hancock, C. W. Starkey, and D. J. Lee, <sup>1</sup>*Kansas State University, Manhattan.*

A total of 180 weaning pigs (average initial BW of 5.7 kg) were used to determine the effects of stickwater on pelleting characteristics of diets and growth performance of pigs. Treatments were a non-fat control, choice white grease (CWG), and stickwater (SW) substituted for 1/3, 2/3, and 3/3 (DM basis) of the CWG. Diets were formulated to 1.7, 1.5, and 1.3% lysine with 3, 5, and 7% fat for d 0 to 7, 7 to 21, and 21 to 35, respectively. The diets were steam conditioned at 83 C in a CPM Master Model HD pellet mill equipped with a die having 4-mm openings. The diets with fat required less energy to pellet than the nonfat control ( $P < .001$ ). Energy consumption decreased with as much as 2/3 replacement of the CWG, but complete replacement of CWG with SW increased energy consumption (cubic effect,  $P < .001$ ). The nonfat control had greater pellet durability index (ASAE, S269.3) than diets with added fat ( $P < .001$ ), but pellet durability index increased as SW was added to replace the CWG (linear effect,  $P < .001$ ). When the diets were fed to pigs, there were no differences in ADG, ADFI, or gain/feed for d 0 to 7 or d 7 to 21 ( $P > .12$ ), but the diets with added fat supported greater gain/feed than the nonfat control for d 21 to 35 ( $P < .001$ ) and overall ( $P < .01$ ). There was a trend (quadratic,  $P < .07$ ) for overall gain/feed to increase when 1/3 of the CWG was replaced with SW and to decrease with total replacement of the CWG. In conclusion, replacement of CWG with SW increased pellet durability and up to 2/3 of the CWG could be replaced with SW without negative effects on growth performance. Our findings suggest that SW is an economically attractive addition to diets for nursery pigs.

Item	Non-fat	CWG	1/3 SW	2/3 SW	3/3 SW	SE
Energy consumption, kWh/t	10.5	6.7	6.4	5.7	7.9	.1
Pellet durability, %	78.4	25.6	45.5	74.8	90.6	.7
ADG, g	644	647	663	676	645	13
ADFI, g	943	893	907	928	914	19
Gain/feed, g/kg	683	725	731	728	706	9

**Key Words:** Pigs, Fat, Stickwater

**223 Effect of site of weaning and dietary DE content on performance of pigs to 56 d of age.** C. L. Levesque\*<sup>1,2</sup>, J. F. Patience<sup>1</sup>, E. Beltranena<sup>1</sup>, and R. T. Zijlstra<sup>1</sup>, <sup>1</sup>*Prairie Swine Centre, Inc.*, <sup>2</sup>*University of Saskatchewan, Saskatoon, Canada.*

The impact of segregated early-weaning with pigs weaned at 15 to 20 days of age in a high health herd is poorly understood. Also, little is

known about the response of pigs to varying DE content in starter diets. The objectives of this study were to evaluate the effects of site of weaning and dietary DE content on piglet performance to 56 d of age. A total of 216 newly-weaned pigs ( $17 \pm 2$  d of age;  $5.3 \pm 0.2$  kg BW) were randomly assigned within 3 replicate groups to pens of 7 pigs each and to one of 6 treatments arranged as a 2 X 3 factorial: on-site or off-site nurseries and 3 dietary energy levels (3.35, 3.50 or 3.65 Mcal DE/kg). Penning, drinkers and feeders were identical at each site. Dietary DE content was increased by changing the ratio of low to high energy ingredients Air quality (NH<sub>3</sub>, CO<sub>2</sub>, temperature and relative humidity) was monitored weekly to ensure similar environments at both sites. All pigs initially received commercial starter diets. At 25 d of age, pigs were assigned to Phase III experimental diets (3.5 g dlys/Mcal DE). At 41 d of age, pigs were switched to Phase IV diets (3.1 g dlys/Mcal DE). Individual pig BW and feed disappearance were measured weekly. Compared to on-site pigs, off-site pigs were significantly heavier at 56 days of age (23.4 kg vs. 21.2 kg;  $P < 0.05$ ) and had a higher ADG (0.43 kg/d vs. 0.39 kg/d;  $P < 0.01$ ). Pigs on the low DE diet ate more feed ( $P < 0.01$ ) and grew faster ( $P < 0.01$ ) compared to the mid or high DE diets. These results indicate that weaning off-site results in faster piglet weight gain, even when the herd of origin is of high health status. Increasing the DE content of the diet did not result in an increase in performance in early-weaned pigs. The source of increased dietary DE content may have affected the observed response to dietary energy.

Days of age	ADG (kg/d)				ADFI (kg/d)			
	Low DE	Mid DE	High DE	P	Low DE	Mid DE	High DE	P
25-41	0.47	0.41	0.43	0.01	0.56	0.49	0.49	0.01
42-56	0.65	0.63	0.63	NS	0.81	0.76	0.73	0.05

**Key Words:** Segregated-early weaning, digestible energy, pig

**224 Effects of dietary L-carnitine on growth performance of nursery pigs.** D. E. Real<sup>\*1</sup>, M. U. Steidinger<sup>1</sup>, J. L. Nelssen<sup>1</sup>, M. D. Tokach<sup>1</sup>, R. D. Goodband<sup>1</sup>, S. S. Dritz<sup>1</sup>, J. M. DeRouche<sup>1</sup>, J. C. Woodworth<sup>1</sup>, and K. Q. Owen<sup>2</sup>, <sup>1</sup>Kansas State University, Manhattan, <sup>2</sup>Lonza Inc., Fair Lawn, NJ.

A total of 626 early-weaned nursery pigs (initially 5.1 kg and  $14 \pm 4$  days of age) were used in three trials to evaluate the effects of added dietary L-carnitine on nursery pig growth performance. Pigs were blocked by weight and randomly allotted to one of five dietary treatments. Trial 1 had 4 or 5 pigs per pen and 7 replicate pens per treatment, while trials 2 and 3 had 8 pigs per pen and 5 and 6 replicate pens per treatment, respectively. In all three trials, the treatments consisted of a control diet containing no added L-carnitine, or the control diet with 25, 50, 75, or 100 mg/kg of added L-carnitine. Phase I, II, and III were from d 0 to 14, d 14 to 24, and d 24 to 34, respectively, in trial 1, and d 0 to 10, d 10 to 24, and d 24 to 38, respectively, in trials 2 and 3. During phase I, pigs fed increasing levels of L-carnitine had similar growth performance ( $P > 0.05$ ). During phase II, increasing L-carnitine (0, 25, 50, 75, or 100 mg/kg) increased (linear  $P < 0.04$ ; quadratic,  $P < 0.10$ ) ADG (325, 354, 361, 366, and 359 g/d) and improved (linear  $P < 0.01$ ; quadratic  $P < 0.01$ ) gain/feed (0.584, 0.654, 0.678, 0.673, and 0.675). However, a treatment  $\times$  trial interaction was observed for G/F ( $P < 0.04$ ). In trial 3, increasing L-carnitine did not improve G/F to the same magnitude as in trials 1 and 2. For phase III, increasing L-carnitine had no effect on growth performance. Overall, pigs fed increasing L-carnitine tended (linear,  $P < 0.08$ ) to have greater ADG (366, 383, 377, 395, and 385 g/d). Also, L-carnitine improved (linear,  $P < 0.01$ ) gain/feed (0.712, 0.741, 0.733, 0.738, and 0.750). Therefore, these results suggest 25 to 50 mg/kg of added L-carnitine improved ADG and G/F in nursery pigs during phase II.

**Key Words:** Pigs, Nursery, Carnitine

**225 Effects of dietary L-carnitine on growth performance and apparent nutrient digestibility in weanling pigs.** M.J. Rincker<sup>\*1</sup>, S.D. Carter<sup>1</sup>, R.W. Fent<sup>1</sup>, B.W. Senne<sup>1</sup>, and K.Q. Owen<sup>2</sup>, <sup>1</sup>Oklahoma State University, Stillwater, <sup>2</sup>Lonza, Inc., Fairlawn, NJ.

Two experiments were conducted to evaluate the effects of supplementing L-carnitine to the diets of weanling pigs on growth performance and apparent total tract digestibility. In Exp. 1, 128 weanling pigs (5.5 kg

initial BW; 18 d) were randomly allotted based on BW, sex, and litter to four dietary treatments containing 0, 25, 50, or 100 ppm L-carnitine. Pigs were fed in three dietary phases (P1: d 0-10; P2: d 11-24; and P3: d 25-38 with 1.6, 1.4, and 1.2% Lys, respectively). Phase 1 and 2 diets were complex corn-soybean meal-dried whey based containing animal plasma, blood meal, and lactose, while diets for P3 were corn-soybean meal based. Pigs and feeders were weighed weekly for the determination of ADG, ADFI, and G:F. There were 6 pens/trt of 4-6 pigs/pen. ADG, ADFI, and G:F for the 38-d study were, respectively: 337, 347, 370, and 363 g; 503, 502, 516, and 523 g; and .669, .692, .717, and .693. Dietary L-carnitine increased ADG (linear,  $P < .09$ ) and G:F (quadratic,  $P < .03$ ) for d 0-38. However, this improvement in ADG and G:F associated with L-carnitine was greatest during Phase 2 (linear,  $P < .03$ ). In Exp. 2, six sets of four littermate barrows (4.9 kg; 18 d) were randomly allocated to the four dietary treatments as in Exp. 1. Pigs were housed individually in metabolism chambers and a 5-d total but separate collection of urine and feces was performed during each phase (P1: d 4-9, P2: d 17-22, and P3: d 29-34). There were no treatment by period interactions; therefore, data were pooled across periods. Growth performance trends were similar to those observed in Exp. 1. Increasing L-carnitine resulted in a slight improvement (quadratic,  $P < .10$ ) in energy and nitrogen digestibility with the greatest response observed in pigs fed 25 to 50 ppm L-carnitine. These results suggest that the addition of 50 ppm L-carnitine improved growth performance and, to a lesser degree, nutrient digestibility in weanling pigs.

**Key Words:** Carnitine, Weanling pigs, Digestibility

**226 Influence of increasing dietary niacin on starter pig performance.** D. E. Real<sup>\*1</sup>, J. L. Nelssen<sup>1</sup>, M. D. Tokach<sup>1</sup>, R. D. Goodband<sup>1</sup>, S. S. Dritz<sup>1</sup>, J. M. DeRouche<sup>1</sup>, B. W. James<sup>1</sup>, M. J. Webster<sup>1</sup>, and E. Alonso<sup>2</sup>, <sup>1</sup>Kansas State University, Manhattan, <sup>2</sup>Lonza, Inc., Fair Lawn, NJ.

Two experiments were conducted using 415 pigs (initially 4.8 kg and  $12 \pm 2$  days of age) to determine the influence of increasing dietary niacin on starter pig performance. Pigs were blocked by weight and randomly allotted to one of five dietary treatments. There were 5 pigs per pen with 7 replicate pens per treatment in Exp. 1, and 8 pigs per pen with 6 pens per treatment in Exp. 2. Diets were fed in four phases: SEW (d 0 to 4), Transition (d 4 to 8), Phase 2 (d 8 to 22) and Phase 3 (d 22 to 35). Lysine levels in each phase were 1.70, 1.60, 1.50, and 1.30%, respectively. Diets were formulated to meet or exceed the pigs' tryptophan requirement. In both experiments, pigs were fed the control diet with no added niacin or the control diet with 27.5, 55, 82.5, or 110 mg/kg of additional niacin. There were no experiment  $\times$  treatment interactions ( $P > 0.20$ ). From d 0 to 8, increasing niacin improved (quadratic,  $P < 0.05$ ) ADG (127, 121, 143, 134, and 129 g/d) and ADFI (149, 148, 161, 162, and 150 g/d). From d 8 to 22, increasing niacin tended (linear,  $P < 0.10$ ) to improve gain/feed (0.697, 0.730, 0.717, 0.727, and 0.712). From d 22 to 35, increasing dietary niacin had no effect ( $P > 0.10$ ) on growth performance. Overall, pigs fed increasing niacin tended (quadratic,  $P < 0.11$ ) to have greater ADG (339, 340, 348, 341, and 341 g/d). In summary, adding niacin to the diet resulted in a quadratic increase in ADG and ADFI with the greatest response found with the addition of 55 mg/kg of niacin from d 0 to 8 after weaning. Therefore, these results suggest feeding 55 mg/kg added niacin to nursery pigs to improve growth performance during the initial period after weaning.

**Key Words:** Pig, Vitamin, Niacin

**227 Variation in the ileal digestible amino acid content of soybean meal as affected by location of production.** T.A.T.G. van Kempen<sup>\*1</sup>, I.B. Kim<sup>1</sup>, A. Jansman<sup>2</sup>, M.W.A. Verstegen<sup>2</sup>, J.D. Hancock<sup>3</sup>, D.J. Lee<sup>3</sup>, V.M. Gabert<sup>4</sup>, D.M. Albin<sup>4</sup>, and D. Mahan<sup>5</sup>, <sup>1</sup>North Carolina State University, <sup>2</sup>Agricultural University Wageningen, <sup>3</sup>Kansas State University, <sup>4</sup>University of Illinois, <sup>5</sup>Ohio State University.

To assess differences in soybean meal quality that are related to location of production, researchers in IL, KS, NC, NL (Netherlands), and OH each collected locally processed soybean meal samples. Samples were from the 1998 harvest season and taken at least 15 days apart after processing. These samples were assayed for ileal digestibility and compared to a common shared source of soybean meal and soy protein concentrate as controls. A low-protein (4.5% CP) casein diet was used for determining endogenous nitrogen and amino acid losses. Digestibility



was determined at each research station using seven 35 kg barrows surgically fitted with ileal cannulas. The pigs were used in a 7x7 Latin square design. The experimental diets had 17% CP originating only from the test material, except for the casein diet. The pigs were fed twice daily 12 h apart. The feeding allowance was  $45 \text{ g kg}^{-0.75} \text{ meal}^{-1}$ . Following a 5-d adaptation period, ileal digesta were collected for two 12-h periods in 2 consecutive days for determination of ileal digestibility. Variation in amino acid digestibility was minor among and within sites with a tendency for one KS and one NL sample to have a higher digestibility than two other NL samples. Overall, the NL samples had less digestible Lys and Met than all other samples. Variation in digestibility of amino acids was small between locations. The soybean meals tested in this experiment were approximately 4% higher in total amino acids than that reported in the NRC (1998). True digestibilities, however, were similar to NRC values except for Cys and Thr, which were 5 and 3 percentage points lower in this experiment. These results show that the soybean meals evaluated from several locations were relatively consistent in their digestibility.

**Key Words:** Swine, Digestible amino acids, Soybean meal

**228 Effects of soybean meal particle size on amino acid and energy ileal digestibilities in grower-finisher swine.** N.D. Fastinger\* and D.C. Mahan, *The Ohio State University, Columbus.*

A study evaluated the effect of soybean meal (SBM) particle size reduction on subsequent amino acid and energy ileal digestibilities. Four levels of a SBM source were processed through a hammer mill to achieve average particle sizes of approximately 900, 600, 300, and 150 microns. Included in the seven treatments were two control diets, one containing another source of SBM (900 microns) and the other soy protein concentrate (SPC). The seventh treatment was a low-protein (5% casein) diet that was used to determine endogenous amino acid losses for calculating true digestibilities. Fourteen crossbred barrows with a mean body weight of 28 kg were surgically fitted with cannulas at the distal ileum. The experiment was a 7 x 7 Latin Square design conducted in two replicates. Treatment diets were fed at a constant level during each 7-d period with ileal digesta samples collected for 2-d following a 5-d adaptation period. The amount of feed provided was based upon metabolic body weight ( $0.09 \times \text{kg}^{0.75}$ ) and was increased 150 to 200 g between each collection period. Apparent and true digestibility of amino acids was calculated using 0.50% chromic oxide as a dietary marker. Apparent digestibility of isoleucine, methionine, phenylalanine, and valine increased linearly ( $P < 0.05$ ) as particle size decreased. True digestibility of isoleucine, methionine, phenylalanine, and valine increased linearly ( $P < 0.05$ ) as particle size decreased. The average of the ten essential amino acids showed that both apparent and true digestibility increased as particle size decreased, whereas the average of the non-essential amino acid digestibilities was not affected. Energy digestibility was not affected by SBM particle size reduction. These results suggest that a reduction in particle size of SBM increased essential amino acid digestibility but had no effect on non-essential amino acid digestibility. The largest improvement in digestibility was obtained when soybean meal was approximately 600 microns.

**Key Words:** Soybean meal, Ileal digestibility, Particle size

**229 The influence of soy oligosaccharides on apparent and true ileal amino acid digestibilities and fecal consistency in growing pigs.** M. R. Smiricky\*, D. M. Albin, J. E. Wubben, V. M. Gabert, C. M. Grieshop, and G. C. Fahey, Jr., *University of Illinois, Urbana.*

Soybean oligosaccharides (OS), specifically raffinose and stachyose, have been implicated in impairing nutrient digestibility and causing flatulence. Little conclusive evidence exists concerning soy OS detrimental effects on the gastrointestinal tract, especially digestion. Fourteen ileally cannulated PIC pigs (BW = 35 kg) were randomly allotted to a 77 Latin square to evaluate the influence of raffinose and stachyose on nutrient digestibility and fecal consistency. Semipurified diets containing soy protein concentrate (SPC) or soybean meal (SBM) as the protein source were fed. Soy solubles (SS), a byproduct of SBM processing, was used to increase dietary raffinose and stachyose concentrations. The seven dietary treatments were SPC, SPC + 9% SS, SBM, SBM + 9% SS, SBM + 18% SS, SBM + 4% alpha-galactosidase, and a low protein

casein diet used to determine true digestibility. The diets were formulated to contain 17% CP and 0.5% chromic oxide. The experimental periods were divided into a 5 d adaptation followed by 2 d of ileal digesta collection. The diets and digesta were analyzed for DM, CP, Cr, amino acids, and raffinose and stachyose. Fecal consistency was measured via fecal scores on d 6 and 7 of each experimental period. The SPC + 9% SS diet resulted in depression ( $P < 0.05$ ) in the digestibilities of N and most amino acids. The digestibilities of N and amino acids were the same ( $P > 0.05$ ) for all SBM-containing diets, with the exception of the amino acids Tyr and Glu. The addition of alpha-galactosidase did not improve N or amino acid digestibilities with the exception of Val and Tyr. Raffinose digestibility was improved ( $P < 0.05$ ) by the addition of alpha-galactosidase, but was not affected by any other dietary treatment. Stachyose digestibility was decreased ( $P < 0.05$ ) in the SBM + 9% SS and SBM + 18% SS treatments. Fecal consistency was not affected ( $P > 0.05$ ) by dietary treatment. Soy OS have minor effects on digestibility in growing pigs when present at these concentrations.

**Key Words:** Pig, Digestibility, Oligosaccharides

**230 Characterizing the feeding value of extruded-expelled soybean meal (Express<sup>TM</sup>) with or without added fat in a commercial swine production facility.** M. J. Webster\*<sup>1</sup>, S. S. Dritz<sup>1</sup>, R. D. Goodband<sup>1</sup>, M. D. Tokach<sup>1</sup>, J. L. Nelsens<sup>1</sup>, J. C. Woodworth<sup>1</sup>, M. De La Latta<sup>1</sup>, and N. W. Said<sup>2</sup>, <sup>1</sup>Kansas State University, <sup>2</sup>Insta-Pro International.

A total of 1,200 gilts was used to evaluate the effects of replacing conventionally processed soybean meal with extruded-expelled soybean meal on finishing pig growth performance. Dietary treatments were arranged in a  $2 \times 3$  factorial with two sources of soybean meal (solvent extracted or extruded-expelled) and three levels of added fat (none, 3.4, and 7% initially than decreasing in the next three dietary phases). Energy levels were based such that the higher energy in extruded-expelled soybean meal (with or without added fat) was equal to that provided by solvent extracted soybean meal with added fat. From 24.5 to 61.2 kg, pigs fed extruded-expelled soybean meal had greater ADG and G/F compared to those fed solvent extracted soybean meal. Increasing added fat in either extruded-expelled- or solvent extracted soybean meal-based diets, increased ADG and G/F (linear,  $P < 0.0003$ ). From 61.2 to 122.5 kg, pigs fed extruded-expelled soybean meal and/or increasing added fat had decreased feed intake ( $P < 0.04$ ). For the overall growing-finishing period, ADG was unaffected ( $P > 0.61$ ) by increasing energy density. However, ADFI was decreased ( $P < 0.05$ ; 1.96 vs. 1.91 kg/d) and G/F increased ( $P < 0.02$ ; .382 vs. .391) as energy density of the diet was increased with extruded-expelled soybean meal. Increasing added dietary fat also reduced (linear,  $P < 0.01$ ) ADFI (1.98, 1.93, and 1.88 kg/d) and increased (linear,  $P < 0.01$ ) G/F (.375, .387, and .398). Carcass leanness was not affected by dietary treatment. These results indicate that increasing dietary energy density by using extruded expelled soybean meal and/or added fat, improves feed efficiency in finishing pigs reared in a commercial environment.

**Key Words:** Soybean meal, Processing, Finishing pigs

**231 Comparison of extruded/expelled soybean meal with conventionally processed soybean meal in swine diets from weaning to market weight.** A. M. Tucker\*, P. S. Miller, A. J. Lewis, and R. L. Fischer, *University of Nebraska, Lincoln.*

Two consecutive studies were conducted to evaluate the efficacy of replacing conventionally processed soybean meal (SBM) with extruded/expelled SBM (ESBM) in swine diets from weaning to slaughter. Experiment 1 was a randomized block design and used 480 pigs (240 barrows and 240 gilts; initial BW = 4.1 kg) in a 28-d nursery trial. There were two, 14-d feeding phases, and pigs were given ad libitum access to feed and water. Pen was the experimental unit, and pigs were fed either a control diet (C) or a diet containing ESBM (E). Diets were formulated on an equal lysine basis. Pigs fed C grew 16% faster ( $P < 0.05$ ) and were 14% more efficient ( $P < 0.05$ ) than those fed E. There was no difference in ADFI. However, plasma urea concentrations (PUC) were greater ( $P < 0.05$ ) for pigs fed the E diet than for pigs fed C. Experiment 2 was a growing-finishing trial that used 240 pigs (120 barrows and 120 gilts) from Exp. 1 (initial BW = 12.5 kg) in a  $2 \times 2$  factorial arrangement. Pigs were fed either a C or E diet and there were four possible Exp. 1-Exp. 2 diet combinations (C-C, C-E, E-C, or E-E). Diets were formulated on an equal lysine basis, and there were three feeding phases (12 to

50, 50 to 80, and 80 to 106 kg). Blood samples were taken at the end of each phase to measure PUC. Backfat (BF) and longissimus muscle area (LMA) were measured by real-time ultrasound on the final day of the trial, and carcass measurements were gathered at the slaughter facility. Pigs fed C had 4.8% and 3% greater ( $P < 0.05$ ) ADG and ADG/ADFI than pigs fed E during Phase 1. There were no differences in BF or LMA between treatments. Pigs fed C had heavier hot carcass weights ( $P < 0.05$ ) and 2.83% more pounds of lean ( $P < 0.05$ ) than pigs fed E. The results suggest that using ESBM in nursery diets may not provide optimal growth performance. Growth performance was also hindered slightly in pigs fed ESBM during the growing-finishing trial.

**Key Words:** Pigs, Extruded/Expelled soybean meal, Growth

### 232 Supplementation of $\alpha$ -1,6-galactosidase and $\beta$ -1,4-mannanase to improve soybean meal utilization by growing-finishing pigs. S. W. Kim\*, Z. H. Zhang, K. T. Soltwedel, and R. A. Easter, *University of Illinois, Urbana.*

Two experiments were conducted to test a hypothesis that dietary supplementation of a carbohydrase mixture (mainly composed of  $\alpha$ -1,6-galactosidase and  $\beta$ -1,4-mannanase) improves nutrient utilization of soybean meal by growing-finishing pigs. In the first experiment, eight, surgically cannulated, finishing pigs were fed soybean meal based diets containing the carbohydrase to evaluate supplemental effects (0.05 and 0.10%) on apparent and true ileal digestibility of soybean meal. A low-protein (4.4% CP) casein diet was fed to measure endogenous protein loss. Both apparent and true ileal digestibilities of major limiting amino acids, i.e., lysine, threonine, and tryptophan, were improved ( $P < 0.05$ ) when the carbohydrase was added to the diet at 0.05% and 0.10% levels. Energy was utilized more efficiently ( $P < 0.05$ ) by pigs fed the diet containing 0.05% carbohydrase than the control diet. In the second experiment, one hundred growing pigs (24.1 $\pm$ 0.6 kg) were fed either a control diet (3,278 Mcal ME/kg diet) or a low energy diet containing carbohydrase (3,109 Mcal ME/kg diet, 5% lower ME than the control diet) for four weeks. Supplemental level of the carbohydrase was 0.05%. Pigs fed the low energy diet with carbohydrase had similar average daily gain to that of pigs fed the control diet either by each week or during the entire experimental period. Average daily feed intake of pigs did not differ between treatments during the first, second, and third weeks. During the fourth week, pigs fed the low energy diet with carbohydrase had higher feed intakes ( $P < 0.05$ ) than pigs fed the control diet. However, there was no difference in average daily feed intake during the entire experimental period. Gain:feed ratio did not differ between the treatments either by each week or during the entire experimental period. According to the results, supplementing a carbohydrase mixture (mainly composed of  $\alpha$ -1,6-galactosidase and  $\beta$ -1,4-mannanase) improves nutrient digestibility of soybean meal. Pigs fed the low energy diet had similar growth performance to that of pigs fed the control diet.

**Key Words:** Pigs, Carbohydrase, Soybean meal

### 233 Inclusion of Coastal Bermuda grass (BG) in feed negatively affects energy digestibility but not feed efficiency in swine. I. B. Kim\*, B. Hansen<sup>2</sup>, J. Hansen<sup>3</sup>, R. Dvorak<sup>4</sup>, E. van Heugten<sup>1</sup>, and T. van Kempen<sup>1</sup>, <sup>1</sup>North Carolina State University, <sup>2</sup>Browns of Carolina, <sup>3</sup>Murphy Family Farms, <sup>4</sup>Alltech Inc..

Three trials were conducted to evaluate the nutritional value of BG with or without Fibrozyme<sup>®</sup>. In Exp. 1, eight barrows (129kg) were used to study fecal digestibility of 14.5% BG supplemented to a corn-soy diet with/without 0.02% Fibrozyme. Diets were fed at  $70\text{g} \times \text{kg}^{-0.75} \times \text{day}^{-1}$  and tested in a Latin square design. Each period consisted of 5-d adaptation and 2-d collection of freshly voided feces. BG decreased gross energy (E) digestibility 14% ( $P < 0.05$ ), while Fibrozyme improved E digestibility 6% ( $P < 0.05$ ) versus no Fibrozyme addition. There was no significant difference in nitrogen (N) digestibility. In Exp. 2, 30 gestating sows (204 kg, parity 3.6, 30-50d post-breeding, limit-fed) were used to evaluate sun-dried, chopped BG supplemented at 0, 2, 4, 6, 8, and 10% to a corn-SBM gestation diet. The experiment was conducted using an 8-d adaptation and 2-d collection of freshly voided feces. BG decreased E digestibility quadratically as a function of inclusion level ( $E \text{ dig.} = 92.7 - 1.58 \times (\text{BG}) + 0.10 \times (\text{BG})^2$ ,  $R^2 = 0.77$ ,  $P < 0.01$ ) and N digestibility linearly ( $N \text{ dig.} = 89.5 - 0.89 \times (\text{BG})$ ,  $R^2 = 0.67$ ,  $P < 0.01$ ). In Exp. 3, 60 pigs (102kg) were used to determine the growth performance

over a period of 4 wk as affected by BG with/without Fibrozyme. Treatments were: (1) control (corn-soy diet), (2) control+ sun-dried, chopped BG 10%, (3) diet 2+Fibrozyme 0.02%, (4) control+pelleted BG 10%, and (5) diet 4+Fibrozyme 0.02%. Barrows and gilts were blocked by gender and weight and allotted to one of five dietary treatments in a randomized completed block design with 2 pigs/pen. Although BG decreased energy utilization in Exp. 1 and 2, no negative effects of BG on feed efficiency were noted in Exp. 3. In conclusion, BG has a negative effect on energy digestibility that can be partially ameliorated through the addition of a fiber degrading enzyme. BG, however, has apparently no negative effect on feed efficiency, possibly because it reduces activity and, therefore, energy expenditure.

**Key Words:** Bermuda grass, Energy and nitrogen, Sow and finisher

### 234 Energy and nitrogen balance of pigs fed commercial red sorghum, identity-preserved white sorghum, or corn. R.W. Fent\*, S.D. Carter, M.J. Rincker, and B.W. Senne, *Oklahoma State University, Stillwater.*

An experiment was conducted to determine the ME concentration and nitrogen digestibility of one corn and two sorghum (S) samples grown within an 80-km radius during the same crop year. Twelve sets of 3 littermate barrows (25.9 kg) were housed individually and allotted randomly to 3 dietary treatments. Experimental diets (1.08% Lys) consisted of mill-run corn (C), mill-run red sorghum (RS), or a white endosperm sorghum variety (WS) (90.0%) with casein (6.14%), crystalline amino acids, and vitamin/mineral source. Pigs were allowed a 5-d adjustment period to the diets followed by a 4-d collection of feces and urine. Data are reported on a DM basis unless otherwise noted. GE and CP concentration of the C, RS, and WS were 4,495, 4,379, and 4,420 kcal/kg, and 9.34, 10.48, and 10.50%, respectively. GE intakes for pigs fed diets containing C, RS, and WS were 5,335, 5,198, and 5,186 kcal/d. Fecal GE excretion was greater ( $P < .01$ ) for pigs fed S versus C diets, but there was no difference between pigs fed RS and WS diets. Urinary energy excretion was similar across treatments. ME for diets containing C, RS, and WS were 3,950, 3,614, and 3,656 kcal/kg, respectively. ME concentration for the diet containing C was greater ( $P < .01$ ) compared with the S diets, but there was no difference in ME between RS and WS diets. However, DE:GE and ME:GE tended ( $P < .15$ ) to be greater for diets containing WS compared with RS. A previous study found that the ME of casein was 4,150 kcal/kg (as-fed) and thus the casein in the diet (6.14%) supplied 255 kcal/kg. Subtraction of the ME from casein resulted in ME concentrations, on an as-fed basis, of 3,600, 3,325, and 3,370 kcal/kg for C, RS, and WS, respectively. Nitrogen absorption and retention were greater ( $P < .02$ ) for pigs fed the diet containing C compared with pigs fed S. These results indicate that the digestibility of energy and nitrogen were lower in mill-run red sorghum versus mill-run corn. Also, energy and nitrogen balance was similar between pigs fed mill-run red sorghum and white sorghum.

**Key Words:** Sorghum, Metabolizable energy, Pigs

### 235 Digestibility of energy and amino acids in high-oil corn for grower pigs. R.T. Zijlstra\*<sup>1</sup>, T.E. Sauber<sup>2</sup>, and J.F. Patience<sup>1</sup>, <sup>1</sup>Prairie Swine Centre Inc., Saskatoon, Canada, <sup>2</sup>DuPont Specialty Grains, Johnston, IA.

Digestibility of energy (E) and amino acids (AA) of high-oil corn has not been characterized thoroughly or related to chemical characteristics. Four near-isogenic sample-pairs of high-oil and regular corn and one standard corn sample were analyzed by proximate analyses. Diets consisting of one specific corn sample (96.3%), vitamins and minerals (3.3%), and chromium oxide (0.4%) as an indigestible marker were fed at 3 x Maintenance requirement for DE in a 3-period cross-over study to 20 grower pigs cannulated at the distal ileum, for 6 pigs per diet. Per period, diets were fed for 8 d with an AA top dress added on d 1 to 4, feces were collected on d 6, and ileal digesta was collected on d 7 and 8. In high-oil vs regular corn, concentration of ether extract (EE) was 4.2% higher (9.1 vs 4.9%), resulting in a 6% higher GE content (4853 vs 4589 kcal/kg DM), and concentration of CP was 9.5 vs 9.1%, acid-detergent lignin (ADL) 0.51 vs 0.41%, and starch 68.2 vs 71.3%. Total-tract E digestibility was 1.1% lower (87.4 vs 88.3%;  $P < 0.05$ ) in high-oil vs regular corn; however, DE content was 5% higher ( $P < 0.05$ ) in high-oil vs regular corn (4238 vs 4052 kcal/kg DM). The DE content could be predicted ( $P < 0.05$ ) using single-regression by corn GE ( $R^2 = 0.93$ ), EE ( $R^2 = 0.90$ ), and CP ( $R^2 = 0.49$ ), but not by ADF or NDF ( $P >$

0.05). Ileal E digestibility was similar (75.4 vs 76.4%;  $P > 0.10$ ) between high-oil vs regular corn; however, ileal DE content was 4% higher ( $P < 0.05$ ) in high-oil vs regular corn (3660 vs 3503 kcal/kg DM). Apparent ileal digestibility of lysine was 2.4% higher ( $P < 0.10$ ) in high-oil vs regular corn (64.0 vs 61.6%), although less difference was observed in standardized digestibility of lysine (76.3 vs 75.5%). The increase in oil content within each near-isogenic sample pair was related ( $R^2 = 0.47$ ) to an increase in apparent ileal lysine digestibility. In summary, feeding high-oil versus regular corn does result in more E and AA available to the pig to support metabolic functions.

**Key Words:** Pig, Corn, Digestibility

**236 Digestible and metabolizable energy values of nutritionally-enhanced corn hybrids for growing pigs.** C.M. Peter\*, T.M. Parr, and D.H. Baker, *University of Illinois at Urbana-Champaign*.

Four sets of four littermate barrows (BW = 25 kg) were used to determine the DE and ME values of several nutritionally-enhanced corn hybrids compared to those of a normal corn (NC) hybrid. The hybrids investigated included a high-protein/high-oil (HPO), a high-protein/high-oil/low-phytate (HPOLP), and a waxy (WX) hybrid. Pigs were individually housed in stainless-steel metabolism cages in a thermoneutral environment. The four corn hybrids were analyzed for amino acid concentrations, and diets containing corn as the sole source of energy were then fortified with amino acids to fulfill the digestible amino acid profile of Illinois Ideal Protein. Diets also were supplemented with calcium, phosphorus, vitamins, and trace minerals to meet or exceed nutrient recommendations. The four corn diets were fed twice daily for the duration of the experiment, and equal-feeding within replicate was employed during the collection period. Ferric oxide was added to the diets as a fecal marker to determine initiation and termination of fecal collection. After a 6-d adaptation period, total urine and fecal excreta were collected for 5 d. Samples of feed and excreta were analyzed for dry matter, nitrogen, and gross energy (bomb calorimetry). Gross energy values (kcal/kg DM) of the four corn hybrids were 4,515 (NC), 4,487 (WX), 4,622 (HPO), and 4,590 (HPOLP). The DE and ME values on a DM basis were higher ( $P < 0.05$ ) for HPO (4,033 and 3,986 kcal/kg) compared to those of NC (3,793 and 3,749 kcal/kg), WX (3,874 and 3,829 kcal/kg), and HPOLP (3,945 and 3,901 kcal/kg). The DE and ME values did not differ ( $P > 0.10$ ) between WX and HPOLP, but WX and HPOLP had greater ( $P < 0.05$ ) DE and ME values compared to NC. Stacking the low-phytate trait on the HPO hybrid (HPOLP) reduced

( $P < 0.05$ ) DE and ME values compared to HPO. Similar studies with adult chickens showed that HPOLP was lower ( $P < 0.05$ ) in ME than HPO. These results indicate that WX, HPO, and HPOLP have higher DE and ME than NC, but that HPOLP has about 2% less DE and ME than HPO.

**Key Words:** Pigs, Corn hybrids, ME

**237 Efficacy of high oil corn in reducing the severity of a PRRSV challenge in growing pigs.** B.T. Christopherson\*, R.C. Thaler, C.C. Chase, H.H. Stein, S.H. Pohl, R.A. Bohlke, and B.D. Rops, *South Dakota State University, Brookings*.

The objectives of this experiment were to determine the effects of high oil corn (HOC) on the aerosol transmission of the porcine reproductive and respiratory syndrome virus (PRRSV), and the effects of HOC on PRRSV seroconversion in growing pigs. One hundred PRRSV negative gilts (25 kg) were housed in 1 of 2 mirror imaged rooms. Both rooms contained 10 pens with 5 pigs/pen, and each room had its own separate ventilation and manure handling systems. The study was arranged in a 2 x 2 factorial arrangement. The main effects consisted of a dietary energy source, (#2 yellow corn (CON) and HOC), and with or without a virus challenge (VC). A three-phase feeding program was used and in each phase the CON and HOC diets contained the same lysine:calorie ratio. Animals were allowed to acclimate to their respective diets for two weeks before the VC was administered. At day 14, fifty pigs (pigs from 5 pens in each room) were inoculated with a TCID<sub>50</sub> of PRRSV virus 2367 (1 X 10<sup>4</sup>) intranasally. Blood was collected from day 7 to day 64 post-inoculation (PI) and analyzed for serum PRRSV concentrations via ELISA. PRRSV serum antibody titers peaked at day 50, and then declined thereafter. Serum antibody titers remained lower ( $P = .05$ ) for animals fed HOC diet compared to those fed the CON diet. Animals fed the HOC diet experienced a delay ( $P = .03$ ) in measurable PRRSV serum antibody titers compared to those fed the CON diet. Also, it took longer for the PRRSV negative pigs fed HOC to seroconvert than the PRRSV pigs fed the CON diet. This delay may be attributed to effects of HOC on dust reduction affecting the aerosol transmission of PRRSV, and/or the biological effect HOC has on PRRSV challenged pigs. The data from this study indicates that HOC delays the seroconversion of PRRSV challenged pigs, and may reduce the onset of PRRSV in growing pigs.

**Key Words:** High oil corn, Porcine reproductive respiratory syndrome virus, Pigs

## ODOR AND NUTRIENT MANAGEMENT

**238 Effects of dietary manipulation on pig performance, manure composition, aerial ammonia, hydrogen sulfide, and odor levels in swine buildings.** D. C. Kendall\*<sup>1</sup>, B. T. Richert<sup>1</sup>, K. A. Bowers<sup>1</sup>, S. A. DeCamp<sup>1</sup>, C. T. Herr<sup>1</sup>, T. E. Weber<sup>1</sup>, D. Kelly<sup>1</sup>, A. L. Sutton<sup>1</sup>, D. W. Bundy<sup>2</sup>, and W. J. Powers<sup>2</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, <sup>2</sup>Iowa State University, Ames, IA.

Two experiments were conducted with grow-finish pigs (n=180) to evaluate dietary manipulation of swine diets to reduce aerial pollutants and nutrient excretion. In Exp. 1, pigs (initial BW=80.3 kg) were placed in two identical, environmentally controlled rooms (2 pigs/pen, and 10 pens/room; 40 pigs/rep) with 2 replications and treatments rotating between rooms. Diets consisted of either a control, corn-soybean diet (11.5% CP, .477% apparent ileal digestible lys; dLys) or a reduced CP diet with supplemental synthetic amino acids formulated with high-available phosphorus corn, 300 PU/kg of phytase, 5% soybean hulls and a non-sulfate trace mineral premix (8.25% CP, .477% dLys; HRP). Aerial ammonia concentration (AAC), hydrogen sulfide (HS), and detection threshold of odor (DT) samples were taken at wk 4 and 6 from both room and exhaust air. Manure samples were collected at wk 0, 3 and 6. Exp. 2 consisted of two replications with 5 pigs/pen (50 pigs/rep; 82.5 kg). Barrows were fed the same diets as Exp. 1. Two additional diets were formulated for gilts; control (12.6%CP; .51% dLys) and HRP (9.35% CP; .51% dLys). Data collection procedures were identical as to Exp. 1. All diets were formulated to be isocaloric. Due to the similarity in diets and design, manure composition, AAC, HS, and DT data from both experiments were pooled. Pigs fed control diets in Exp. 1 had greater ADG (824 vs. 735 g/d;  $P < .004$ ), higher G:F (0.29 vs. 0.26;

$P < .001$ ), greater loin depth, and less backfat accretion by wk 6. In contrast, the pigs fed the control diets in Exp. 2 had similar growth performance and carcass characteristics compared to pigs fed HRP diets. By wk 6, there was a 48.7% reduction in AAC ( $P < .03$ ) from room air and 49.8% reduction in the exhaust air AAC ( $P < .04$ ) when pigs were fed HRP diets. HS levels were 43.3% lower ( $P < .01$ ) and DT was 38.6% lower ( $P < .05$ ) at wk 6 in rooms where HRP diets were fed. At wk 6, the stored manure from pigs fed HRP diets had 27.0% less total-N ( $P < .005$ ), 29.5% lower ammonium-N ( $P < .02$ ), and 51.7% less excreted P ( $P < .02$ ) on a DM basis. The HRP diet was effective at reducing AAC, HS, DT, manure N, P and if adequate amino acid levels are included in the diet, growth performance is comparable.

**Key Words:** pigs, odor, manure composition

**239 Dietary manipulation to reduce aerial ammonia concentration in nursery pig facilities.** J. J. Colina\*, A. J. Lewis, P. S. Miller, and R. L. Fischer, *University of Nebraska, Lincoln*.

The effects of adding *Yucca schidigera* extract or calcium chloride to the diet on aerial ammonia concentration and growth performance were determined in nursery pigs weaned between 11 and 15 d of age (initial BW= 3.5 to 6.0 kg). In each of three trials, 150 crossbred pigs were allotted by weight to three identical, environmentally controlled rooms (10 pigs per pen, 50 pigs per room). In each room, relative humidity, temperature, and ventilation were held constant. Pigs were fed one of three diets: 1) control, containing 23% CP; 2) control plus 125 ppm of *Yucca schidigera* extract (30%); and 3) control plus 1.95% calcium

chloride. Each trial consisted of a 1-wk adaptation period (during which a common diet was fed) and a 4-wk experimental period. Average daily gain (ADG) and average daily feed intake (ADFI) were recorded weekly. Aerial ammonia was measured daily using aspiration tubes and three times during the last week of each trial using diffusion tubes. Manure samples were taken from the pit in each room twice a week during the experimental period. Blood samples were collected on the last day of each trial. Data were analyzed as a 3 x 3 Latin square. There were no differences in ADFI among pigs fed any of the three diets and no differences in ADG and ADG/ADFI between pigs fed the control diet and pigs fed the *Yucca schidigera* diet. However, pigs fed the calcium chloride diet had lower ( $P < 0.05$ ) ADG and ADG/ADFI than pigs fed the other two diets. Aerial ammonia concentrations measured with aspiration tubes increased as the experiment progressed, and by the fourth week ammonia concentrations were greater ( $P < 0.01$ ) in the rooms in which pigs were fed the control diet than in the rooms in which the other two diets were fed. Aerial ammonia measured with diffusion tubes, manure nitrogen, and pigs' plasma urea concentrations did not differ among diets. Although aerial ammonia concentrations were relatively low in this study, both the addition of *Yucca schidigera* extract and calcium chloride to diets of nursery pigs reduced ammonia concentration.

**Key Words:** Pigs, Ammonia, Growth

**240 Nitrogen balance of pigs fed low-protein amino acid supplemented diets with different soybean fractions.** B.W. Senne\*, S.D. Carter, R.W. Fent, and M.J. Rincker, *Oklahoma State University, Stillwater.*

Six sets of four littermate barrows (31 kg) were used to determine the nitrogen balance of pigs fed low crude protein-AA supplemented diets (LPAA) with either SBM, soy protein concentrate (SPC), or soy protein isolate (SPI) as the primary source of dietary N. Treatments were: (1) fortified corn-SBM control, (2) as 1 with CP reduced 4% units with added Lys, Met, Thr, Trp, and Val (LPAA-SBM), (3) as 2 with SPC replacing SBM (LPAA-SPC), and (4) as 2 with SPI replacing SBM (LPAA-SPI). Both SPC and SPI replaced SBM on a digestible lysine basis. Corn was used to replace the differences among SBM, SPC, and SPI. Pigs were allowed ad libitum access to both feed and water and housed individually in metabolism chambers that allowed for the total but separate collection of urine, feces, and refused feed. Rate and efficiency of gain were not affected ( $P > .15$ ) by treatment; however, pigs fed LPAA-SPC or LPAA-SPI consumed less ( $P < .03$ ) feed than pigs fed LPAA-SBM or the corn-SBM control. Dry matter excretion as percentage of intake was greatest ( $P < .03$ ) for pigs fed the corn-SBM control diet. Daily N intakes during the 5-d collection period were 39.5, 34.4, 31.0, and 31.0 g/d (DM basis) for the four dietary treatments, respectively. Fecal N excretion was reduced by 5% in pigs fed LPAA-SPC and 17% in pigs fed LPAA-SPI compared with LPAA-SBM. Urinary and total excretion of N were reduced ( $P < .01$ ) by 45 and 32%, respectively, in pigs fed LPAA compared with pigs fed the control diet. Absorption and retention of N (% of intake) were: 87.6, 86.3, 85.7, and 87.3%; and 56.0, 65.9, 64.6, and 64.9%. On a percentage of intake basis, pigs fed LPAA diets tended to absorb less ( $P < .10$ ), but retain more ( $P < .01$ ) N than pigs fed the control diet; however, there were no differences in absorption or retention due to SPC or SPI. These results suggest that lowering the CP content of a corn-SBM diet by 4% units reduces total N excretion. Also, the use of more refined fractions of the soybean in LPAA diets produced a numerical stepwise decrease in fecal and total N excretion.

**Key Words:** Pigs, Nitrogen, Excretion

**241 Reduction of odorous compounds in pig manure through dietary fiber manipulation.** S.L. Hankins\*, A.L. Sutton<sup>1</sup>, J.A. Patterson<sup>1</sup>, B.T. Richert<sup>1</sup>, A.J. Heber<sup>1</sup>, D.T. Kelly<sup>1</sup>, K.B. Kephart<sup>2</sup>, R. Mumma<sup>2</sup>, E. Bogus<sup>2</sup>, and S.D. Carter<sup>3</sup>, <sup>1</sup>*Purdue University*, <sup>2</sup>*Pennsylvania State University*, <sup>3</sup>*Oklahoma State University.*

Three replicate 4X4 Latin square trials were conducted with cecally cannulated grow-finish crossbred barrows to determine the effects of amino acid (AA) utilization and fiber additions to the diet on odorous compounds from cecal contents, fresh manure, and stored manure. Diets included 1) Standard 15% CP corn-soy diet, 0.75% Lys; 2) 11% CP corn-soy diet, 0.30% crystalline Lys (.76% total Lys), 0.05% Meth (.25% total Meth), 0.05% Trp (.15% total Trp) and 0.11% Thr (.51%

total Thr); 3) Diet 2 with 10% soybean hulls (SH); and 4) Diet 2 with 10% dried sugar beet pulp (SBP). Pigs were fed *ad libitum* and housed in metabolism stalls for the collection of cecal contents, feces and urine. Headspace gas from fresh and stored manure was analyzed for volatile organic compounds. Cecal ammonia nitrogen (AMM) was reduced 25% and 19% with the addition of SH or SBP to the low CP diet, respectively ( $P < .05$ ). The addition of SH to the low CP diet reduced cecal total nitrogen (TN) 24% ( $P < .05$ ). Urinary TN was reduced 28% with the low CP diet with AA and 36% when a fiber source was added to the same diet ( $P < .05$ ). AMM in fresh manure was decreased 31%, 55% and 47% with the low CP, low CP plus SH and low CP with SBP diets, respectively, and was 35% less when the low CP diet was fed with SH as compared to the low CP diet alone ( $P < .01$ ). TN in fresh manure was reduced 38%, 50%, and 42% when the low CP diet, low CP diet plus SH, and low CP diet plus SBP were fed, respectively ( $P < .01$ ). AMM and TN in stored manure were reduced 26% and 29%, 39% and 32%, and 64% and 46% when the low CP with AA, low CP plus SH and low CP plus SBP diets were fed, respectively ( $P < .01$ ). VFA in stored manure tended to be lower from pigs fed the SBP diet compared to other diets. The addition of SH and SBP reduced benzene, dimethyl disulfide, 2,2-dimethyl hexane and hexane in stored manure. This suggests that fiber addition to a low CP swine diet can help reduce nuisance odors.

**Key Words:** Odor, Pig, Fiber

**242 Comparison of nutrient retention to total collection for determination of nutrient excretion.** J.D. Spencer<sup>1</sup>, J.W. Frank<sup>1</sup>, A.M. Gaines\*<sup>1</sup>, and G.L. Allee<sup>1</sup>, <sup>1</sup>*University of Missouri-Columbia.*

Two different methods of determining phosphorus (P) retention were utilized in order to quantify the amount of P excreted. Sixty male broiler chicks (1-d) were allotted to one of three treatments with each treatment having a three phase feeding regimen. Diets were corn/soybean meal based diets that differed in total P content. There were 4 birds/pen, and 5 pens/trt. Feed intake and body weight gain were recorded weekly. Total excreta from each phase of growth (days 0-21, 21-42, and 42-49) was collected, dried, weighed, and analyzed for determination of P balance. At the end of the growth period (49-d), pens of birds were fasted (12 h), killed, and ground 3 times through a 6.4 mm die. Ground tissue samples for each pen were further homogenized with dry ice in a food processor. Sub-samples were then lyophilized and analyzed for total P. There was no difference in ADG, ADFI, or feed efficiency among trts. Total P balance calculated from total excreta analysis was 53.4, 42.3, and 61.3% of P intake for trts. 1, 2, and 3, respectively ( $P \leq .01$ ). Body retention of P from tissue analysis was determined to be 43, 33, and 52% of P intake for trt. 1, 2, and 3, respectively ( $P \leq .01$ ). Among treatments, calculated P balance utilizing total excreta was similar to values of percent P retained in the body. Estimated P retention was 10% higher when utilizing total excreta. These results suggest that total body retention and total collection of excreta result in similar differences in P balance among treatments, and that both procedures are a useful method to determine P excretion. Therefore, nutrient retention in the body is a practical method to estimate nutrient excretion from animal facilities in instances where effluent or litter nutrient content is difficult to sample accurately.

**Key Words:** Nutrient excretion, waste, Phosphorus

**243 Composting feedlot and dairy manure as a manure management alternative: Compost characteristics, crop yields, and nutrient recoveries.** G. E. Erickson\*<sup>1</sup>, T. J. Klopfenstein<sup>1</sup>, W. Luedtke<sup>1</sup>, and G. Lesoing<sup>2</sup>, <sup>1</sup>*University of Nebraska-Lincoln*, <sup>2</sup>*University of Missouri.*

Over 7 years, 16,000 Mg of feedlot and dairy manure were composted and spread on 450ha to determine costs, characteristics, nutrient recoveries, and crop yields from large-scale field studies comparing compost (+comp) to no-compost (-comp) treatments. Finished feedlot compost averaged 1050 Mg/year but was variable due to cleaning of open-dirt feedlot pens. Nutrient content can also vary, but averaged .65% N and .47% P as % of DM across 7 years. Nitrogen recovery was estimated using ash content as an internal marker. Recovery varied across years with a range of 61 to 89% of the initial N recovered during composting. Costs of composting were evaluated from 1994 to 1997 and averaged \$1.38/Mg and \$3.58/Mg for composting feedlot manure and dairy manure, respectively. These costs include labor and machinery for turning and mixing.

Costs are greater for dairy than feedlot manure due to higher initial % moisture requiring addition of bulk carbon sources and increased number of compost turnings. Impact of compost application on crop yields was evaluated using check strips in large-scale production fields managed similarly except compost treatment. Yields were monitored annually following a one-time, 22.4 Mg/ha application of compost in irrigated and dryland fields. Yields for +comp were increased ( $P < .01$ ) by 6% or 558 kg/ha and 8% or 627 kg/ha compared to -comp the first year after application to irrigated and dryland corn, respectively. Similarly, +comp treatment for irrigated soybeans increased yields ( $P = .06$ ) by 2.2% or 84 kg/ha the first year; however, dryland soybean yields were not different ( $P > .45$ ) between +comp and -comp. Wheat and grain sorghum yields were also increased ( $P < .04$ ) for +comp compared to -comp by 301 kg/ha (12%) and 157 kg/ha (2.2%), respectively. Carryover effects from compost application years subsequent to the first were variable between crops; however, application costs were offset by return from yield improvements for every crop evaluated except dryland soybeans. Despite increased costs for composting feedlot and dairy manure, composting is a viable management alternative.

**Key Words:** Compost, Manure management, Cattle

**244 Effect of ractopamine and dietary crude protein on nitrogen and phosphorus excretion from finishing pigs.** S.A. DeCamp<sup>\*1</sup>, S.L. Hankins<sup>1</sup>, A. Carroll<sup>1</sup>, D.J. Ivers<sup>2</sup>, B.T. Richert<sup>1</sup>, A.L. Sutton<sup>1</sup>, and D.B. Anderson<sup>2</sup>, <sup>1</sup>Purdue University, <sup>2</sup>ELANCO Animal Health, A Division of Eli Lilly and Company.

Twenty-four Dekalb crossbred barrows housed in metabolism stalls (initial BW=84 kg) were used to determine the effect of ractopamine (RAC) on nutrient excretion. Pigs were randomly assigned to one of four diets (TRT): 1) 13.8% CP, 0.80% Lys; 2) 13.8% CP, 1.10% Lys + 20 ppm RAC; 3) 16.1% CP, 1.10% Lys; and 4) 16.1% CP, 1.10% Lys + 20 ppm RAC. Pigs were acclimated to the diets for 5 d prior to a 5-d collection of urine and feces. Pigs were offered 2200 g/d of their TRT and 4800 g/d water in four equal fractions at 0, 600, 1200, and 1800 h. Initial and final BW were taken to determine ADG and feed efficiency. TRT 1 had the lowest and TRT 2 had the highest ( $P < .05$ ) fecal output (485, 654, 578, 609 g/d; TRT 1-4 respectively) with the 16.1% CP diets (TRT 3 and 4) intermediate. RAC TRT 2 and 4 had decreased ( $P < .05$ ) urine output (3040, 2622, 3038, 2690 mL/d; TRT 1-4 respectively) and tended to decrease total manure output (3525, 3276, 3616, 3299 g/d; TRT 1-4 respectively) on an as is basis compared to those fed no RAC. Pigs fed low CP and RAC diets excreted less total N (24.6, 15.8, 30.1, 21.0 g/d; TRT 1-4 respectively;  $P < .05$ ) and less urinary N (18.9, 9.8, 23.5, 14.4 g/d; TRT 1-4 respectively;  $P < .05$ ). The amount of N retained increased with the addition of RAC (25.2, 36.7, 28.9, 38.1 g/d; TRT 1-4 respectively;  $P < .05$ ). The N retained as % of intake increased when pigs were fed either low CP ( $P < .05$ ) diets (50.5, 69.9, 49.0, 64.5%; TRT 1-4 respectively) or the addition of RAC ( $P < .05$ ). The amount of P excreted in the urine increased when pigs were fed TRT 1 (1.30, 0.81, 0.89, 0.48 g/d;  $P < .05$ ) compared remaining TRT. TRT 4 and TRT 1 differed in the % of retained P of that absorbed with TRT 2 and TRT 3 not being different (82.5, 89.2, 86.4, 93.2 %; TRT 1-4 respectively;  $P < .05$ ). In conclusion, on a daily basis, ractopamine improved N utilization, decreased N excretion, tended to decrease manure output and improved P utilization with minimal changes in P excretion.

**Key Words:** Pigs, Ractopamine, Nutrient excretion

**245 Odor production in stored manure from ractopamine (RAC) fed pigs.** S.L. Hankins<sup>\*1</sup>, S.A. DeCamp<sup>1</sup>, B.T. Richert<sup>1</sup>, D.B. Anderson<sup>2</sup>, D.J. Ivers<sup>2</sup>, A.J. Heber<sup>1</sup>, and A.L. Sutton<sup>1</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, <sup>2</sup>Elanco Animal Health, A Division of Eli Lilly and Company, Greenfield, IN.

Twenty-four DeKalb crossbred barrows (Initial BW=84 kg) were housed in metabolism stalls and randomly allotted to one of four dietary treatments (TRT): 1) 13.8% CP, 0.80% Lys control; 2) 16.1% CP, 1.10% Lys; 3) 16.1% CP, 1.10% Lys + 20 ppm RAC; and 4) 13.8% CP, 1.10% Lys + 20 ppm RAC to evaluate the effect of CP and RAC on odor production in anaerobically stored manure. Pigs were adapted to TRT for 14 d followed by a 3 d total fecal and urinary collection. Feces and non-acidified urine were collected twice daily prior to feeding and refrigerated. The feces and urine from 2 pigs/TRT were paired to form 3 slurry samples, mixed to a 7.5% DM and used in duplicate jars in an anaerobic simulated pit system. Two liters of slurry were used as the initial inoculum

in 4 L jars. Additional slurry was frozen in 38 mL aliquots and added to jars 3 times/wk. Jars were capped and air was pumped across the headspace of each jar at 200 cc/min throughout the 64 d trial. Slurry and air samples were taken at d 0, 17, 35 and 64. Slurry contents were analyzed for ammonia nitrogen (AMM) and volatile fatty acids (VFA). Air samples were taken in 10 L Tedlar bags and used for an eight-person panel olfactometry analysis. At the four time points, slurry AMM was reduced ( $P < .05$ ) 8-21% and 21-47% from pigs fed RAC at 16.1% and 13.8% dietary CP, respectively, compared to similar CP diets without RAC. The 13.8% CP diet + RAC had the lowest ( $P < .05$ ) AMM values at all time points. Total VFA production was higher ( $P < .05$ ) for the 16.1% CP diet with no RAC compared to the TRT with RAC and was 21%, 28% and 23% higher ( $P < .05$ ) at d 17, 35 and 64, respectively, than the 13.8% CP diet + RAC. Olfactometry results indicated a detection threshold 51% higher ( $P < .05$ ) for the 16.1% CP diet without RAC compared to the 13.8% CP diet without RAC at d 64. This indicates that a 13.8% CP diet + 20 ppm RAC could significantly decrease slurry AMM and VFA production in stored manure to help reduce odor emission.

**Key Words:** Pigs, Odor, Ractopamine

**246 Abatement of Ammonia and Hydrogen Sulfide Emissions from a Swine Lagoon using a Polymer Biocover.** J.A. Zahn<sup>\*1</sup>, A.E. Tung<sup>2</sup>, B.A. Roberts<sup>2</sup>, and J.L. Hatfield<sup>3</sup>, <sup>1</sup>National Swine Research Center - USDA-ARS, Ames, IA, <sup>2</sup>Monsanto, EnviroChem Systems Division, St. Louis, MO, <sup>3</sup>National Soil Tilth Laboratory - USDA-ARS, Ames, IA.

Emissions of ammonia ( $\text{NH}_3$ ) and hydrogen sulfide ( $\text{H}_2\text{S}$ ) above certain thresholds are subject to U.S. EPA reporting requirements under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA; 40 C.F.R. Part 302). Determination of whether emissions from confined animal feeding operations (CAFOs) approach these reporting thresholds depends upon accurate measurement of emission rates under field conditions. Additionally, the development of strategies for abatement of emissions from CAFOs may allow CAFOs with emissions approaching the reporting thresholds to avoid CERCLA reporting requirements. In this study, a nonintrusive, micrometeorological method was evaluated for measuring the effect of a commercial polymer biocover on the emission rate of  $\text{H}_2\text{S}$ ,  $\text{NH}_3$  and methane ( $\text{CH}_4$ ) from an east-central Missouri swine lagoon with a total surface area of 7,800  $\text{m}^2$ . The flux rate of  $\text{NH}_3$ ,  $\text{H}_2\text{S}$ , and  $\text{CH}_4$  was monitored continuously from two adjacent, circular ( $d = 66$  m) control and treatment plots during three independent sampling periods that ranged between 52 and 149 hours. Abatement rates were observed to undergo a temporal acclimation event, where  $\text{NH}_3$  abatement efficiency improved from 17% to 54% ( $p < 0.0001$  to 0.0005) and  $\text{H}_2\text{S}$  abatement efficiency improved from 23% to 58% ( $p < 0.0001$ ) over a period of 3 months. The increase in abatement efficiency for  $\text{NH}_3$  and  $\text{H}_2\text{S}$  over the sampling period was correlated with the development of a stable anaerobic floc layer on the bottom surface of the biocover that reduced mass transfer of  $\text{NH}_3$  and  $\text{H}_2\text{S}$  across the surface. Analysis of methanogenesis activity showed that the biocover enhanced the rate of anaerobic digestion by 25% when compared to the control. The biocover-enhanced anaerobic digestion process was shown to represent an effective mechanism to counteract accumulation of methanogenic substrates in biocovered lagoons.

**Key Words:** Manure Management, Concentrated Animal Feeding Operations, Air Quality

## PHYSIOLOGY

**247 Fixed-time insemination versus insemination after estrus in replacement beef heifers synchronized with GnRH, Norgestomet, and PGF<sub>2α</sub>.** G. C. Lamb<sup>\*1</sup>, L. R. Miller<sup>2</sup>, J. M. Cassady<sup>2</sup>, C. M. Zehnder<sup>2</sup>, and A. DiCostanzo<sup>2</sup>, <sup>1</sup>North Central Research and Outreach Center, University of Minnesota, Grand Rapids, <sup>2</sup>Department of Animal Science, University of Minnesota, St. Paul.

Our objectives were to compare conception and pregnancy rates of a fixed-time AI protocol versus AI after a detected estrus. A heifer development operation in east-central Minnesota acquired 521 crossbred heifers. Prior to the spring breeding season, 57 of the heifers were culled based on poor reproductive tract scores. The remaining 464 heifers received a 100- $\mu$ g injection of GnRH and a 6-mg norgestomet implant on d -7. The norgestomet implant was removed on d 0 when heifers received a 25-mg injection of PGF<sub>2 $\alpha$</sub> . The heifers were then randomly assigned to three AI synchronization programs: 1) heifers received a second 100- $\mu$ g injection of GnRH and were inseminated at a fixed-time on d 2 (Time+G; n = 154); 2) heifers received a fixed-time insemination on d 2 without an injection of GnRH (Time; n = 159); and, 3) estrus was detected from d 1 to 6 followed by AI according to the am/pm rule (Estrus; n = 151). A clean-up bull was introduced 10 days after AI for 60 days. Transrectal ultrasonography was used to determine the presence of a viable fetus 30 d after AI. Of the treated heifers 73% had reproductive tract scores (RTS) of 2 or 3, whereas 27% had RTS of 4 or 5. Conception rates did not differ among synchronization treatments (42.2, 41.1, and 39.0% for Time+G, Estrus, and Time treatments, respectively). Overall pregnancy rates following the breeding season were similar (71.8, 64.3, and 71.7% for Time+G, Estrus, and Time treatments, respectively). Heat detection rates for the Estrus heifers were 71.5% and time from PGF<sub>2 $\alpha$</sub>  to AI in those heifers differed (P < .05) as RTS increased (61.8, 54.8, 52.5, and 49.7 h for RTS scores of 2, 3, 4, and 5, respectively). We conclude that a fixed-time AI yielded similar fertility results to AI after a detected estrus in peripuberal heifers.

**Key Words:** Beef Heifers, Artificial Insemination, Estrous Synchronization

**248 Fixed-time insemination in peripuberal, light-weight replacement beef heifers synchronized with PGF<sub>2α</sub> and GnRH.** C. R. Dahlen<sup>\*1</sup>, G. C. Lamb<sup>2</sup>, C. M. Zehnder<sup>1</sup>, L. R. Miller<sup>1</sup>, and A. DiCostanzo<sup>1</sup>, <sup>1</sup>Department of Animal Science, University of Minnesota, St. Paul, <sup>2</sup>North Central Research and Outreach Center, University of Minnesota, Grand Rapids.

We determined whether acceptable pregnancy rates could be achieved after ovulation synchronization in peripuberal replacement beef heifers using GnRH and PGF<sub>2 $\alpha$</sub> . Crossbred heifers (n = 514) were wintered in eastern Minnesota and were randomly assigned to three estrous synchronization treatments: 1) heifers received two 25-mg injections of PGF<sub>2 $\alpha$</sub>  on d -12 and d 0 and then detected for estrus and inseminated artificially using the am/pm rule (Control; n = 173); 2) heifers received a 100- $\mu$ g injection of GnRH on d -6, followed by a 25-mg injection of PGF<sub>2 $\alpha$</sub>  on d 0, and on d +2 heifers received a fixed-time AI with a 100- $\mu$ g injection of GnRH (GPG; n = 172); and, 3) same as GPG protocol, but heifers received an additional 100- $\mu$ g injection of GnRH on d -12 (GGPG; n = 169). A clean-up bull was introduced 10 days after AI for 60 days. On d -12, d -6, and d 0 transrectal ultrasonography was used to monitor ovarian response to treatments in a subset of heifers (30 per treatment) and at 30 d after AI to determine the presence of a viable fetus. Average weight at initiation of the breeding season was 295  $\pm$  3 kg and were correlated (P < .001) to reproductive tract score (RTS) and pregnancy rates. Synchronized pregnancy rates were greater (P < .05) in GGPG (25.4%) and GPG (22.1%) than Control (12.7%) heifers and overall pregnancy rates were 9, 21, 32, and 31% for heifers with RTS of 2, 3, 4, and 5, respectively (P = .18). In the GPG and GGPG treatments, the average diameter of 22 follicles induced to ovulate by GnRH was 14.2  $\pm$  .8 mm (range = 10 to 23.6 mm). The percentages of heifers with a CL on d 0 were (79%) 23/29, (72%) 21/29, and (83%) 25/30 for GGPG, GPG, and Control heifers, respectively. We conclude that a fixed-time ovulation synchronization program using GnRH and PGF<sub>2 $\alpha$</sub>  improved pregnancy rates in peripuberal, light-weight heifers, but was unable to increase pregnancy rates to meet industry standards.

**Key Words:** Beef Heifers, Artificial Insemination, Estrous Synchronization

**249 A comparison of fixed-time insemination protocols for replacement beef heifers.** F. N. Kojima<sup>\*</sup>, M. F. Smith, S. L. Wood, M. S. Kerley, K. K. Graham, and D.J. Patterson, University of Missouri, Columbia, MO/USA.

Improvements in estrus response and synchrony of estrus were reported recently for heifers whose estrous cycles were synchronized with melengestrol acetate (MGA) and prostaglandin F<sub>2 $\alpha$</sub>  (PG), and when PG was administered 19 d instead of 17 d following MGA withdrawal. The objective of this experiment was to compare pregnancy rates of heifers synchronized with the 14-19 d MGA-PG protocol and inseminated a single time at 72 h after PG (control) compared to pregnancy rates of heifers that received an injection of GnRH 48 h after PG and inseminated 16 h following GnRH injection (treated). Heifers in each treatment were fed MGA (0.5 mg-hd<sup>-1</sup>-d<sup>-1</sup>) for 14 d followed by an injection of PG (25 mg Lutalyse) 19 d after MGA withdrawal. Treated heifers received an injection of GnRH (100  $\mu$ g Cystorelin) 48 h after PG. Blood samples were collected from all heifers 10 d and 1 d prior to the initiation of treatment with MGA to determine pubertal status. Heifers at two locations (n = 176) were assigned to treatment based on age, weight, and pubertal status. Heifers were inseminated with semen from one sire by either of two experienced technicians. Fertile bulls were introduced for 45 d beginning 2 wk after the AI period. Pregnancy rates resulting from fixed-time AI were 49% (43/88) and 41% (36/88) for control and treated heifers, respectively (P > 0.10). Pregnancy rates at the end of the 45 d natural service period were 84% (74/88) and 87% (78/88) for control and treated heifers, respectively (P > 0.10). These data indicate that the 14-19 d MGA-PG protocol followed by an injection of GnRH 48 h after PG and subsequent insemination 16 h later failed to improve pregnancy rates resulting from fixed-time AI when compared with results from a single insemination 72 h after PG. Further studies are needed to determine whether pregnancy rates resulting from fixed-time AI may be improved with a change in the timing of administration of GnRH after the MGA-PG protocol.

**Key Words:** Beef Heifer, Estrus Synchronization, Melengestrol Acetate

**250 Timed insemination in beef heifers after synchronization of estrus and ovulation with melengestrol acetate (MGA) and prostaglandin F<sub>2α</sub>.** S.K. Johnson<sup>\*</sup> and K.R. Harmoney, <sup>1</sup>Kansas State University, Hays,KS.

Increasing the interval between MGA withdrawal and PGF<sub>2 $\alpha$</sub>  injection from 17 to 19 d increased estrus response and improved synchrony in heifers. Most heifers were observed in estrus 60 h after PGF<sub>2 $\alpha$</sub> . The objective of this study was to determine if a single fixed-time insemination would result in pregnancy rates comparable to that for heifers bred after heat detection. Yearling heifers from two herds (H1 n=118, H2 n=441) were fed MGA (.5 mg/hd) daily for 14 d. On d 19 after withdrawal of MGA, heifers received 25 mg PGF<sub>2 $\alpha$</sub>  (h 0). Heifers receiving no further treatment served as controls (C; n=401) and were inseminated based on the following schedule. Heifers observed in estrus from dark to 0800 (EAM), 0800 until 1200 (LAM), and noon until dark (PM) were inseminated beginning at 1330, 1800 and 0800 the following morning, respectively. In the treated group (TB; n=158), heifers received an injection of GnRH (100  $\mu$ g) and were inseminated 60 h after PGF<sub>2 $\alpha$</sub> . TB heifers observed in estrus before 38 h were not inseminated at 60 h (n=7). Actual time of insemination for the TB heifers was 63.5 - 68.5 h in both herds. Pregnancy rate (30 - 45 d) during the synchrony period (0 to 120 h) was greater (P<.05) for C (255/401, 63.6%) than for TB (74/158, 46.6%) heifers. The proportions of C heifers in estrus from 48 to 72 h, 48 to 84 h and 48 to 96 h were 72.1%, 77.8% and 83.3%, respectively. Conception rates to a single sire in C heifers in H2 were examined for EAM (43/54, 79.6%), LAM (14/19, 73.7%) and PM (101/138, 73.2%) and did not differ. Synchronized pregnancy rates differed (P<.05) between sires within herds and between herds. Conception rates for bulls used in H1 were 32.7% (17/52) and 61.0% (36/59) and for H2 were 67.4% (211/313) and 66.3% (67/101). Although the synchronized pregnancy rates were not as high in TB heifers as in C heifers, the pregnancy rate achieved in this study might be acceptable in some production situations.

**Key Words:** Timed AI, Heifers, Estrous Synchronization

**251 Improved fertility in noncycling lactating dairy cows treated with exogenous progesterone during Ovsynch.**

J. R. Pursley\*, P. M. Fricke, H. A. Garverick, D. J. Kesler, J. S. Ottobre, J. S. Stevenson, and M. C. Wiltbank, *NC-113 Regional Research Project.*

Our objective was to determine if increased progesterone (P<sub>4</sub>) before induced luteolysis would enhance fertility in lactating dairy cows. To increase P<sub>4</sub> we tested the effect of an intravaginal progesterone insert (CIDR) administered at the first injection of GnRH of the Ovsynch protocol (an injection of GnRH given 7 d before and another given 48 h after PGF<sub>2α</sub> followed 12 to 18 h later by timed AI [TAI]). The CIDR was removed 2 h prior to PGF<sub>2α</sub> induced luteolysis. Lactating dairy cows (n=634) from six Midwest herds were assigned randomly within parity and stage of lactation to receive Ovsynch or Ovsynch + CIDR at a random stage of an estrous cycle. Blood was sampled to quantify P<sub>4</sub> 10 d before first GnRH, at first GnRH, at removal of CIDR, at PGF<sub>2α</sub>, and 48 h post-PGF<sub>2α</sub> to determine cycling status at time of first GnRH, status at time of PGF<sub>2α</sub> (high or low P<sub>4</sub>), and CL regression. Synchronization rate was defined as the percentage of cows with 1): serum P<sub>4</sub> <1 ng/ml 48 h after PGF<sub>2α</sub> and 2) a follicle >9 mm that disappeared within 48 h after the second GnRH. Size of ovulatory follicle at time of second GnRH and its disappearance 48 h later, and pregnancy diagnosis at 28 and 56 d following TAI, were determined by ultrasound. A location × treatment interaction (P=0.019) occurred for pregnancy rates. Pregnancy rates per TAI (%), % cycling, and average days in milk (DIM) are illustrated in the table below for each location. Noncycling cows (n=182) that received Ovsynch + CIDR had greater (P<0.05) pregnancy rates (55.2%) than noncycling cows that received Ovsynch (34.7%) on d 28 after TAI. Pregnancy loss between 28 and 56 d after TAI was not different between Ovsynch and Ovsynch + CIDR regardless of cycling status. Synchronization rate was similar after the Ovsynch (83.1%) and Ovsynch+CIDR (82.3%) protocols. In summary, a CIDR inserted during the Ovsynch protocol enhanced fertility in non-cycling cows. (NC-113 Regional Research Project Contribution).

No. of cows	96	184	94	99	93	68
	Illi- nois	Kan- sas	Michi- gan	Mis- souri	Ohio	Wis- consin
Ovsynch	49.0	34.4	43.5	42.3	28.6	56.3
Ovsynch+CIDR	72.3*	59.3*	33.3	42.6	41.0	47.2
% cycling	93.8	40.8*	91.5	90.9	63.4	76.5
DIM	117.2	60.0*	100.4	87.7	111.9	80.9

\*P<0.05

**Key Words:** Ovsynch, CIDR, Fertility

**252 Administration of estradiol benzoate at the onset of the CIDR/PGF estrus synchronization procedure increases pregnancy rates in cows but not heifers.** T.L. Steckler<sup>1</sup>, T.G. Nash<sup>1</sup>, J.M. Dahlquist<sup>1</sup>, T.F. Lock<sup>1</sup>, G.A. Bollero<sup>1</sup>, H.D. Hafs<sup>2</sup>, D.B. Faulkner<sup>1</sup>, and D.J. Kesler<sup>1</sup>, <sup>1</sup>University of Illinois, <sup>2</sup>Rutgers University.

Two-hundred and seventy-seven beef heifers and 384 beef cows were included in this two year study. Cattle were managed similarly at two locations: Urbana Beef Unit (Urbana, IL) and the Orr Beef Research Unit (Baylis, IL). All females were administered an intravaginal progesterone (P<sub>4</sub>) insert (CIDR) for 7 d plus an injection of PGF<sub>2α</sub> (Lutalyse<sup>®</sup>) at the time of insert removal (7 d after insertion). Cattle were assigned randomly to each of four doses of estradiol benzoate (EB): 0 mg, 1 mg, 2 mg, and 4 mg. The EB was administered (IM) at the time of CIDR insertion. In addition, blood was collected for determination of P<sub>4</sub> concentrations via an ELISA 10 days before (d -10) and just before (d -0) CIDR insertion. Eighty-five percent of the heifers and 89% of the cows had elevated P<sub>4</sub> (≥1.0 ng/mL) in one or both of the blood samples collected before CIDR insertion suggesting that they were estrus-cycling. Ten and 28 of the CIDRs were not present at the time of CIDR removal suggesting that 3.6% and 7.3% of the heifers and cows, respectively, lost their inserts and were eliminated from the analysis. Conception rates (# pregnant ÷ # in estrus) and pregnancy rates (# pregnant ÷ # treated) were calculated after determining pregnancy via ultrasound examination on about 60 d after AI. Overall, 64% and 79% of the heifers and cows, respectively, were detected in estrus during the first 4 d after insert removal (synchronized). Synchronized conception rates and pregnancy rates were affected differently by dose of EB. For conception

rate in heifers, a cubic effect (P<0.02) was observed, whereas for pregnancy rates in cows, a linear effect (P<0.05) was observed. The heifers administered the 0-mg dose of EB had a synchronized conception rate of 60% followed by a drop (1 mg; 48%), a rebound (2 mg; 63%), and another drop (4 mg; 40%). A similar trend (P=0.07) also occurred for heifer pregnancy rates. In cows, the linear effect in pregnancy rates was positive (0 mg: 45%; 1 mg: 55%; 2 mg: 55%; and 4 mg: 63%) and conception rates averaged 69%. In summary, these data indicate that administration of EB at the onset of the CIDR/PGF estrus synchronization procedure negatively affected synchronized conception rates in heifers but improved synchronized pregnancy rates in cows.

**Key Words:** Estrus synchronization, Estradiol benzoate, Progesterone

**253 Effects of maturity of the potential ovulatory follicle on the ability of estradiol benzoate (EB) to stimulate estrus, ovulation and luteal development in anestrous beef cows.** CR Burke<sup>1,2</sup>, ML Mussard<sup>1</sup>, and ML Day<sup>1</sup>, <sup>1</sup>The Ohio State University, Columbus OH, <sup>2</sup>Dairying Research Corporation, Hamilton, New Zealand.

An injection of estradiol benzoate (EB) after treatment with progesterone is effective in inducing estrus in anestrous cattle, but development of a healthy corpus luteum does not occur in 10-20% of cases. The hypothesis was tested that maturity of the dominant follicle (DF) at progesterone withdrawal influences the incidence of animals having estrus without ovulation, and subsequent luteal development. Twenty-one suckling anestrous beef cows at 29.3 ± 1.7 d postpartum each received an intravaginal progesterone insert (IPI) and 1 mg EB/500 kg BW i.m. (EB1) on d 0. Diameter of ovarian structures were monitored daily by ultrasonography from d -1 to at least 8 d after IPI withdrawal. On detection of new emergence of a follicle wave (d 2.2 ± .2), cows were assigned randomly to have the IPI removed when the new DF was 1 d (Young; YDF; n=11) or 3.9 ± .1 d old (Mature; MDF; n=9). All received .75 mg EB/500 kg BW (EB2) 24 h after IPI removal. Plasma concentrations of progesterone (P<sub>4</sub>) were determined from blood samples collected daily through the subsequent estrous cycle and cross-sectional area of the corpus luteum (CL) was measured every third day. Diameter of the new DF at IPI withdrawal was less (P<0.05) in the YDF group (6.4 ± .2 mm) than the MDF group (11.0 ± .6 mm). Across treatments, estrus was observed in all but one animal within 48 h of EB2. Ovulation of the newly emerged DF and subsequent development of a CL was observed in 9/9 MDF Group cows and in 4/11 cows in the YDF Group (P<0.05). Diameter of the ovulatory DF was greater (P<0.05) in animals of the MDF Group (13.8 ± .4 mm) than in the YDF Group (9.0 ± .6 mm). Mean CL size was greater in the MDF than YDF Group throughout the cycle, and P<sub>4</sub> was greater 12 to 18 d after ovulation (P<0.01). We conclude that maturity of the DF at the time of EB injection after progesterone treatment is a critical determinant of ovulatory response and subsequent luteal development in postpartum anestrous cattle.

**Key Words:** Estradiol Benzoate, Follicle, Estrous Synchronization

**254 Accuracy of a commercially available Early Conception Factor (ECF<sup>TM</sup>) test for determining pregnancy status of inseminated and noninseminated dairy cattle.** M. C. Cordoba<sup>1</sup>, R. Sartori<sup>1</sup>, and P. M. Fricke<sup>1</sup>, <sup>1</sup>University of Wisconsin-Madison.

The Early Conception Factor (ECF<sup>TM</sup>) test (Concepto Diagnostics, Knoxville, TN) is a qualitative assay that reportedly detects a pregnancy-associated glycoprotein present in bovine serum within 48 h of conception. One caveat of previous assessments is that animals with viable embryos early during pregnancy that subsequently undergo embryonic loss before pregnancy diagnosis are incorrectly classified as false positives. To preclude this possibility, noninseminated Holstein cows (n=9) and heifers (n=8) were evaluated as an unequivocal source of nonpregnant animals. In addition, 17 Holstein cows and one heifer were evaluated as an unequivocal source of pregnant animals following nonsurgical recovery of at least one embryo of excellent, good, or fair quality 6 d after AI. Blood samples were collected from all animals 6 d after detected estrus, and serum was stored (-20 C) until analyzed using the commercial test. All tests were performed and evaluated precisely according to the protocol included in the product insert. Each serum sample was evaluated using two tests (T1 and T2), and each test was interpreted by two independent readers (R1 and R2). Sensitivity, specificity, accuracy, positive predictive value, and negative predictive value

of the test was 89%, 6%, 49%, 50%, and 33% for R1, respectively, and 78%, 0%, 40%, 45%, and 0% for R2, respectively. Although the observed agreement between readers (91%, 32/35 for T1; 89%, 31/35 for T2) and between tests for the same serum sample (91%, 32/35 for R1; 94%, 32/35 for R2) was high, the rate of false positives was 94% and 100% for R1 and R2, respectively, and the rate of false negatives was 11% and 22% for R1 and R2, respectively. In conclusion, the ECF<sup>TM</sup> test is an unreliable method for determining pregnancy status of dairy cattle 6 d after estrus and/or AI. Supported by Hatch project WIS04222.

**Key Words:** Early Conception Factor, Pregnancy Diagnosis, Dairy Cattle

### 255 Use of a vaginal mucus electrical resistance probe to alter insemination time and calf gender distribution in dairy heifers. M.L. Pugh, K.R. Sieren, L.L. Timms\*, and C.R. Youngs, *Iowa State University, Ames, IA.*

The objective of this study was to evaluate the use of a vaginal mucus electrical resistance probe (Ovatec) to produce offspring of a predetermined sex. Estrus was synchronized in 13-month old mixed breed dairy heifers using norgestomet implants. Beginning on the morning of implant removal, vaginal mucus electrical resistance measurements were taken every 12 hours for 5 days. Electronic mount detectors (Heatwatch) were also applied to each heifer to aid in estrus detection. Heifers were randomly assigned within breed and inseminated for the production of either a male or female calf using vaginal mucus resistance measurement criteria. Heifers failing to conceive to the synchronized estrus were used in subsequent estrous cycles for measurement of vaginal mucus electrical resistance during a non-synchronized estrus. Heifers that did not return to estrus were examined for pregnancy 35 days after artificial insemination, and pregnant females underwent fetal sex determination 65 days after insemination. Data were analyzed using GLM procedures of SAS. There was no difference in pregnancy rate between synchronized and non-synchronized heifers, although probe readings were lower in synchronized heifers. Heifers inseminated at probe readings < 65 had a higher conception rate (73.3%) than heifers bred at probe readings of 65 - 75 (28.6%), while heifers inseminated at probe readings of > 75 were intermediate (43.8%). Only 10 of 24 pregnancies (41.7%) were of the intended fetal sex. Heifers inseminated 2 hours prior to onset of estrus produced more males (88.9%) than heifers inseminated 23 hours after estrus onset (14.3%), while heifers inseminated 12 hours after onset of estrus were intermediate (50.0%). These results indicate that measurement of vaginal mucus electrical resistance was not an effective tool to alter fetal sex; however, insemination time influenced fetal sex.

**Key Words:** Vaginal mucus, Electrical resistance, calf sex ratio

### 256 Selection for increased placental efficiency (PE) results in increased placental expression of vascular endothelial growth factor (VEGF) in the pig. K.A. Vonnahme\* and S.P. Ford, *Iowa State University.*

We have demonstrated that selecting Yorkshire breeding stock for increased PE (piglet wt to placental wt ratio) results in larger litter size. Placental vessel density (PVD; vessel number per unit area) increases markedly and progressively after d50 of gestation, and is positively correlated with PE and increases in placental expression of VEGF, a potent angiogenic and permeability factor. The objective of this study was to compare PVD and VEGF mRNA expression for d70 and d90 conceptuses from females selected for high PE (n=4), low PE (n=4), and from unselected controls (n=4). At slaughter, fetal wt, placental wt and PE were determined and a section of the fetal-maternal interface was utilized for determination of PVD. Further, placental tissue was evaluated via RNase protection assay for relative levels of VEGF mRNA expression compared to a housekeeping gene. While there was no difference in fetal wt among the 3 groups on either d, placental wt in the high PE group was less (P<.05) than the low PE group on both d70 (168.7 vs 324.0 g) and d90 (194.2 vs 257.4 g) resulting in marked differences (P<.05) in PE (high PE > low PE). Unselected controls exhibited placental wt and PE that were intermediate. Further, the high PE group exhibited a larger litter size (P<.01) than both the unselected and low PE groups (14.1 vs 10.9 and 9.0). Surprisingly, while PVD increased (P<.01) from d70 to d90 (1.8 .1 vs 2.8 .2), there was no group difference. Although no differences were observed on d70, by d90, placentae of conceptuses from the high PE group had greater (P<.01) amount of VEGF mRNA than the unselected controls and the low PE group (1.9 .1 vs 1.5 .1; 1.4 .1).

These data demonstrate that increased placental VEGF mRNA expression is associated with selection for high PE. Although PVD was not greater in the high PE group, a role for the elevated levels of VEGF in increasing vessel permeability or decreasing the distance between uterine and placental capillaries warrants investigation.

**Key Words:** VEGF, Placental efficiency, Pig

### 257 Are hematocrit and placental efficiency selection tools for uterine capacity in swine? J. L. Vallet\*, K. A. Leymaster, J. P. Cassady, and R. K. Christenson, *USDA, ARS, RLH U.S. Meat Animal Research Center, Clay Center, Nebraska.*

It has been proposed that low fetal hematocrit (HC) contributes to the poor survival of crowded fetuses and that placental efficiency (PE, fetal weight (FW)/placental weight (PW)) can be used to select for uterine capacity. These traits were measured in three selection lines: control (C), ovulation rate (OR), and uterine capacity (UC). HC, PW, and FW were recorded on fetuses from unilaterally hysterectomized-ovariectomized gilts of each line at 105 d of gestation (422 litters). HC was greater (P<.01) in UC (38.5 ± .25%) and less (P<.01) in OR (35.4 ± .22%) than C (37.2 ± .23%). PE was greater (P<.05) in OR (4.66 ± .05) than UC and C (4.46 ± .06 and 4.36 ± .05), which did not differ. Similar results were obtained with FW after using PW and PW<sup>2</sup> as covariates, an alternative measure of placental efficiency (APE) that is not correlated with PW. Heritabilities (h<sup>2</sup>) for HC, FW, PW, PE, and APE were .11 ± .07, .05 ± .07, .18 ± .09, .29 ± .08 and .08 ± .07, respectively. Thus, despite its h<sup>2</sup>, PE did not increase in UC. In contrast selection for higher HC may increase uterine capacity. To further explore this possibility, HC was measured on 5 piglets from each of 3 litters at birth, 7 and 24 h after birth. HC was 44.5 ± .9, 34.3 ± .9 and 31.7 ± .9% at birth, 7 h (P<.05), and 24 h. HC was then determined at 12 to 24 h after birth from piglets from each of the three lines (106 litters). HC was lower (P<.01) for UC (36.2 ± .6%) and OR (36.4 ± .5%) than C (38.6 ± .5%). The h<sup>2</sup> for neonatal HC was .03 ± .14. Thus, (1) selection for UC did not change PE; (2) selection for UC increased fetal HC and decreased neonatal HC; (3) HC falls during the early postnatal period; (4) h<sup>2</sup> of fetal HC is positive but low, and (5) neonatal HC is unlikely to be useful as a selection tool due to low h<sup>2</sup>. Alternative methods (e.g., genetic markers, transgenics) to alter fetal HC are needed and may improve fetal survival and litter size.

**Key Words:** Pregnancy, Erythropoiesis, Survival

### 258 Relationship Among Placental Vasculature, Fetal Growth and Offspring Number in Sheep. D.R. Arnold\*, J.D. Kirsch, K.C. Kraft, D.A. Redmer, and L.P. Reynolds, *North Dakota State University, Fargo, North Dakota.*

Placental vasculature and size have a major impact on fetal growth and development. Ultimately, birth weights are affected by many factors including the maternal and fetal genomes. This experiment was conducted to evaluate fetal growth and placental vasculature of two breeds of sheep that are highly prolific versus less prolific. Gravid uteri from straight-bred Columbia (n = 3) and Romanov (n = 4) ewes, and Columbia ewes carrying Romanov fetuses (n = 4, Transfer) were collected at d 130 of gestation. Uteri were weighed and fetuses were removed and weighed. Caruncular (the primary maternal area of nutrient exchange) and cotyledonary (the primary fetal area of nutrient exchange) tissues were perfusion-fixed with 10% formalin and then perfused with a vascular-casting resin (Mercocryl). Perfused tissues were sectioned, stained, and vascular density was determined by morphometry (point counting; number of points touching blood vessels as a percent of total tissue points). Columbia fetuses were larger (4.9 ± 0.4 kg; P<0.01) than Romanov and Transfer fetuses (2.2 ± 0.2 and 3.1 ± 0.2 kg, respectively). Regardless of treatment groups, caruncular tissue (32.1 ± 1.14 %) was more vascular (P<0.01) than cotyledonary tissue (25.2 ± 1.12 %). Romanov caruncular and cotyledonary tissues were more vascular (34.4 ± 1.75 %; P<0.01) than those of Columbia and Transfer (25.3 ± 1.04 and 26.3 ± 1.24 %, respectively). Cotyledonary tissue of the Romanov fetuses in Columbia uteri (Transfer group), were less vascular than Romanov fetuses in Romanov uteri (20.7 ± 1.75 vs 32.3 ± 1.43 %, respectively). In conclusion, the increased vasculature of Romanov placentae may be a component of increased prolificacy of this breed.

**Key Words:** Placental Vasculature, Fetal Growth, Ovine



**259 Selection for Greater Number of Corpora Lutea in Gilts Increased Plasma Follicle-Stimulating Hormone Concentrations in Prepubertal Development.** J. J. Ford\*<sup>1</sup>, D. R. Zimmerman<sup>2</sup>, T. H. Wise<sup>1</sup>, K. A. Leymaster<sup>1</sup>, and R. K. Christenson<sup>1</sup>, <sup>1</sup>USDA, ARS, RLH US Meat Animal Research Center, <sup>2</sup>University of Nebraska, Lincoln.

Concentrations of follicle-stimulating hormone (FSH) were evaluated in gilts to determine if lines differed from two studies in which ovulation rate increased through direct selection for number of corpora lutea (CL). Plasma FSH concentrations (n = 186) were greater (P < 0.05) at 53 and 75 d of age in selected compared to control gilts (774±20 vs. 667±26 ng/ml) of the University of Nebraska gene pool lines. Likewise, plasma FSH (n = 771) on d 34, 55, and 85 was greater (P < 0.05), relative to controls, in gilts of White Composite lines selected for either increased ovulation rate or for greater uterine capacity (642±20 vs. 758±19 and 751±19 ng/ml). Unilateral ovariectomy and hysterectomy were conducted at 160 d of age on random gilts in these 3 lines (n = 377). Ovarian and uterine wt were less (P < 0.01) in the control than in the ovulation rate line. Subsequently, ovulation rate was determined during pregnancy (n ≥ 130 gilts/line). Controls had fewer (P < 0.01) CL than gilts of the ovulation rate line but similar (P > 0.10) numbers to gilts of the uterine capacity line (14.6, 17.7, and 14.7 CL for control, ovulation rate and uterine capacity lines, respectively). Plasma FSH on d 85 correlated positively with subsequent ovulation rate within each line (P < 0.03, 0.001, and 0.08; r = 0.17, 0.30, and 0.15 for control, ovulation rate and uterine capacity lines, respectively). Ovarian wt at 160 d of age also correlated with subsequent ovulation rate (P < 0.03 and 0.001; r = 0.23 and 0.38) in control and ovulation rate gilts but not in uterine capacity gilts (P > 0.10; r = 0.11). Gilts selected for increased number of CL, in two independent studies, had greater concentrations of FSH during prepubertal development than respective controls. The modest but significant, positive association of FSH at 85 d of age with subsequent ovulation rate provides additional support for using plasma FSH in prepubertal gilts to indirectly select for ovulation rate (Cassady et al., J. Anim. Sci. 78:1430. 2000). This would eliminate the costly surgical procedures required to conduct direct selection.

**Key Words:** Ovulation, Follicle-Stimulating Hormone, Ovarian Weight

**260 Effects of estradiol (E) on follicular growth in neonatal pigs.** P. E. Davis\* and M. C. Lucy, University of Missouri, Columbia.

Estrogen receptor  $\beta$  (ER $\beta$ ) mRNA is expressed in follicles initiating growth in the neonatal pig ovary. The possibility that E, acting through ER $\beta$ , could cause the initiation of follicular growth was tested. Four-day-old piglets (n=36) were given no treatment (control; C) or one (T1) or two (T2) 24 mg E implants. Blood was sampled weekly. Pigs were slaughtered on d 18 (n=18) or d 46 (n=18). Combined ovarian weights were measured at slaughter and ovaries were processed for histological analyses. Pigs treated with E had greater plasma E than control (2.8 18.8, 55.8 20.8, and 132.5 17.7 pg/ml for C, T1, and T2; P < .0001). Ovaries were heavier on d 46 (0.16 .01 g) than on d 18 (0.11 .01 g; P < .01) and T1 and T2 ovaries were heavier than C ovaries (0.11 .01, 0.13 .01, and 0.16 .01 g for C, T1, and T2; P < .01). Follicles were classified histologically as F0-1 [oocyte with some cuboidal granulosa cells (CGC) and some flattened granulosa cells in the first layer], F1 (oocyte with one complete layer of CGC), F1-2 (oocyte with more than one complete layer of CGC, but not two), and F>2 (oocyte with more than two complete layers of CGC). The number of F0-1 follicles per section decreased from d 18 (60.7 2.5) to d 46 (51.6 2.6; P < .01) but there was no effect of treatment. The number of F1 follicles per section also decreased from d 18 (6.5 0.5) to d 46 (4.1 0.5; P < .001). A treatment by day interaction (P < .06) was detected for F1 because on d 46 more F1 follicles were present in T1 and T2 (4.6 1.1 and 4.9 0.8) than in C (2.8 0.9). The number of F1-2 follicles per section decreased from d 18 (14.7 1.2) to d 46 (11.1 1.2; P < .05), but there was no effect of treatment. Numbers of F>2 follicles per section increased from d 18 (0.13 0.08) to d 46 (0.45 0.08; P < .01). E treatment, however, attenuated the increase in F>2 follicles on d 46 (0.77 0.14, 0.21 0.17, and 0.36 0.12 for C, T1, and T2; treatment by day, P < .10). In conclusion, E increased ovarian weight and development of F1 follicles but reduced growth of F>2 follicles in neonatal pigs.

**Key Words:** pig, follicle, estradiol

**261 Characterization of uterine porcine amphiregulin.** J. G. Kim\*, J. L. Vallet, G. A. Rohrer, and R. K. Christenson, USDA, ARS, U.S. Meat Animal Research Center, Clay Center, Nebraska.

Uterine capacity is a component trait contributing to litter size in swine. Gene mapping analyses revealed a quantitative trait locus (QTL) for uterine capacity located on chromosome 8. Comparison to the human gene map suggests that the amphiregulin gene may be located in or near the region of the uterine capacity QTL. Amphiregulin is a member of the epidermal growth factor (EGF) family and binds to EGF receptor. The objective of this study was to 1) clone amphiregulin cDNA and 2) map amphiregulin gene. Using reverse transcription-polymerase chain reaction (RT-PCR) and iterative screening of an expressed sequence tag (EST) library, we obtained two forms of amphiregulin cDNA, consisting of 1118 and 1230 bp. The difference between the two forms was a 112 bp deletion corresponding to exon 5 of human amphiregulin gene. Exon 5 codes for the cytoplasmic domain of amphiregulin. The deletion caused a frame shift, which results in a stop codon at the end of the transmembrane domain corresponding to human exon 4. Using RT-PCR analysis, both forms of amphiregulin were present in the endometrium of day 30 pregnant White crossbred and Meishan pigs (n = 4 each). However, the short form appears to be the predominant form. Thus the predominant form in porcine endometrium does not contain the cytoplasmic domain. Because the cytoplasmic domain is known to affect signal transduction, this deletion likely influences the function of the short form of amphiregulin. Sequences of positive clones from a porcine bacteriophage artificial chromosome (BAC) library contained exon 5 indicating that the deletion in the cDNA was likely caused by differential splicing. Using three informative microsatellite markers developed from BAC clones, amphiregulin was mapped to 65 cM on chromosome 8 in the same general area where the uterine capacity QTL exists. These novel findings may provide insight into the function of amphiregulin during pregnancy in pigs.

**Key Words:** Amphiregulin, Endometrium, Uterine Capacity

**262 Control of ovulation rate in swine.** H Cardenas\*<sup>1</sup> and WF Pope<sup>1</sup>, <sup>1</sup>The Ohio State University.

Factors known to affect ovulation rate include age, genetics, health, environment, and physiological processes such as atresia. Important regulatory events that determine the number of ovulatory follicles occur during the follicular phase of the estrous cycle. Follicle-stimulating hormone (FSH) is an important survival factor and regulator of follicular development. FSH actions are mediated by the FSH receptor (FSHR), which has been localized exclusively in granulosa cells within the ovary. Steady state levels of FSHR mRNA remain relatively high during the early follicular phase (day 13 to day 15 of the estrous cycle) but decrease significantly by day 19, as follicles grow and approach ovulation. Local factors, such as growth factors and steroid hormones, might regulate follicular development by controlling expression of gonadotropin receptors or by modulating other processes. The presence of progesterone, androgen and estrogen receptors in ovarian follicles support the concept that steroid hormones exert paracrine or autocrine actions during follicular development. Testosterone and androstenedione are metabolic intermediaries in the synthesis of estradiol. In addition, it has been shown that administration of testosterone or the non-aromatizable androgen, dihydrotestosterone (DHT), increased the number of ovulations in gilts in a dose-dependent manner. Furthermore, administration of DHT up-regulates FSHR mRNA in pre-ovulatory follicles. Androgens appear to modulate FSHR expression which might be one of many regulatory mechanisms of ovulation rate in swine.

**Key Words:** Swine, Follicle, Ovulation rate

**263 Increasing fertilization rate: the male perspective.** W.L. Flowers\*, North Carolina State University.

The number of spermatozoa inseminated and their inherent fertility are central to the influence that males exert on the fertilization process. Consequently, the objective of this review is to examine the relative importance of each of these in terms of the manner in which they affect the ability of boars to produce live pigs. Results from recent studies in which sows were bred with 1, 3, 5, 7, or 9 billion spermatozoa per mating indicate that there is considerable variation among boars in terms of the insemination dose which consistently produces the greatest number of pigs born alive. For 78 of the 200 boars examined (39%), the dose

that yielded the largest litter was outside the generally accepted range for optimal fertility of 3 to 5 billion, motile spermatozoa. In general, litter size tends to be positively associated with most visual tests such as motility and morphology for values that are less than 60%. In contrast, no consistent relationship exists for values greater than 70%. In addition, there are distinct differences in numbers of pigs born alive among boars whose ejaculates do not differ according to these visual criteria. For some boars, it appears that it is possible to compensate for the negative impact of the reduced motility or morphology of their semen on litter size by increasing the number of spermatozoa in the insemination dose. However, for others, this strategy is not effective. Recently, several biochemical tests such as quantification of seminal plasma or sperm membrane proteins and in vitro penetration of mature oocytes have been used to estimate the inherent fertility of boar semen. While the initial results from these studies are encouraging, they still appear to be more qualitative than quantitative in terms of predicting the subsequent litter size produced from an ejaculate. In summary, development of prospective techniques that accurately reflect a boar's fertilization potential appears to be a necessary prerequisite for optimizing the boar's impact on litter size.

**Key Words:** Swine, Boar, Fertility

**264 Early embryonic mortality in the pig.** R.D. Geisert\*<sup>1</sup> and R.A.M. Schmitt<sup>2</sup>, <sup>1</sup>Oklahoma State University, Stillwater, <sup>2</sup>Seaboard Farm, Inc., Guymon, OK.

A major limitation for increasing litter size in swine production is over-coming embryonic loss during the second to third week of gestation. High ovulation rate of modern sow lines has more than supplied the potential embryos necessary to improve overall litter size. Current challenge is determining how to maintain the viability of embryos through the remaining 90 days of gestation to maximize farrowing house production. To achieve this, it is necessary to identify and understand the possible causes of embryonic death. Since fertilization rates are generally high in swine, early embryonic loss during the first 20 days of gestation is considered to critically impact potential litter size. There are three periods that early embryonic loss can occur: 1) Peri-implantation development; 2) Trophoblastic elongation; and 3) Placental attachment. The first two periods are related to time of fertilization and developmental rate for each individual embryo within the litter. Asynchrony in embryonic development relative to uterine development can result in loss of embryos before Day 10 of gestation. Competitive acquisition of adequate uterine space between littermate embryos, essential for bloodflow delivery of nutrients needed for survival to term, is established during conceptus elongation on Day 12 of gestation. Progressive changes in the uterine microenvironment between Day 10 to 16 of gestation play a major role in embryonic survival following trophoblast elongation and placental attachment. In current production systems, there can still be sufficient numbers of embryos present after Day 30 of gestation to provide improvement in overall average litter size at farrowing. However, producers are still faced with the challenge of maximizing placental efficiency for maximal fetal survival to term. Placental space for each individual embryo is more or less established in the period of time following trophoblast elongation. Therefore, fully understanding the biological controls of follicle ovulation rate, synchrony of ovulation, uniformity of conceptus elongation, uterine horn capacity, uterine glandular and vascular development and placental vascularization could provide possible clues to improving embryo quality.

**Key Words:** Pig, Embryo, Pregnancy

**265 Evidence suggests that uterine capacity is a result of both uterine environmental and conceptus genotype effects.** S.P. Ford\*, Iowa State University.

Prenatal losses in U.S. pig breeds range from 30 to 40%, of which greater than 75% occurs before day 30 of gestation, and is thought to result from littermate asynchrony. Numbers of embryos can be experimentally increased to day 30 by utilizing superovulation and superinduction, however, these females will farrow the same number of piglets as untreated controls. These data demonstrate that between day 30 and term there are significant additional conceptus losses, which have led to the conclusion that uterine capacity (i.e. the number of conceptuses a female's uterus can accommodate) is the major limitation to litter size in the pig. The special importance of uterine capacity in the pig may result from the noninvasive epitheliochorial type of placentation in

this species, making the surface area of attachment between the placenta and endometrium a limiting factor. In devising selection schemes for this trait, one could logically conclude the selection for either longer uterine horns or for a reduced conceptus size should potentially increase litter size in the pig. Researchers have evaluated the impact of differences in prepubertal uterine horn length on subsequent uterine capacity using a unilateral hysterectomy-ovariectomy model, but have had modest and variable success in increasing litter size at farrowing. In contrast, results from our laboratory suggest that placental size is moderately heritable, and results in consistent increases in litter size of 2 to 3 piglets in the Yorkshire breed with little impact on piglet birth weights. This selection of pigs for smaller and relatively more efficient placentae (i.e. the number of g of fetus which can be supported by a g of placenta) appears to provide a useful method for increasing litter size in the pig. A careful evaluation of the physiologic and genetic differences of conceptuses with differing placental efficiencies is necessary if we are to determine specific factors impacting litter size in the pig.

**Key Words:** Uterine horn length, Placental efficiency, Litter size

**266 Preweaning survival in swine.** R.L. Matteri<sup>1</sup>, D.C. Lay\*<sup>2</sup>, J.A. Carroll<sup>1</sup>, T.J. Safranski<sup>3</sup>, and T.J. Fangman<sup>3</sup>, <sup>1</sup>Animal Physiology Research Unit, USDA-ARS, Columbia, MO, <sup>2</sup>Livestock Behavior Research Unit, USDA-ARS, West Lafayette, IN, <sup>3</sup>University of Missouri, Columbia, MO.

A limited ability to cope with environmental stressors (cold, disease, limited nutrition), particularly over the first 2 to 3 d of life, predisposes the piglet to relatively high rates of neonatal morbidity and mortality. Due to the serious economic impact, numerous surveys of preweaning losses have been conducted over the last century. While losses are still significant, the existing literature indicates a significant improvement in piglet survival over time, as determined by reports of 35% preweaning mortality in 1924 and 13-15% in 2000. Major sources of mortality have been categorized as overlaying by the sow, insufficient energy intake, and disease. Causes of mortality may be more closely linked than previously believed. Interactions exist between disease, thermoregulation, and nutrition. Piglets with disease and nutritional problems experience hypothermia and express altered behaviors that increase the likelihood of being laid on by the sow. High probabilities of neonatal losses are associated with low birthweight piglets, cold ambient temperatures, and scouring. An understanding of the interactions between environmental stressors and the piglets biology forms the basis of strategies and recommendations for improving preweaning survival.

**Key Words:** Pig, Preweaning, Survival

**267 Use of a vaginal mucus electrical resistance probe to alter insemination time and calf gender distribution in beef heifers.** M.L. Pugh, M. Pence, J.N. Caamano, S. Robbe, L.L. Timms, J.U. Thomson, and C.R. Youngs\*, Iowa State University, Ames, IA.

The objective of this study was to evaluate the use of a vaginal mucus electrical resistance probe (Ovatec) to produce offspring of a pre-determined sex. Mixed breed beef heifers from a private heifer development program were synchronized by feeding 0.5 mg melengestrol acetate (MGA) per head per day for 14 days followed by an injection of prostaglandin F<sub>2</sub>α (PGF<sub>2</sub>α) 17 days after the last MGA feeding. Each heifer was fitted with an electronic estrus detection device (Heatwatch) on the morning of PGF<sub>2</sub>α administration to facilitate detection of behavioral estrus. Vaginal mucus electrical resistance measurements were taken every 12 hours for 96 hours beginning at the time of PGF<sub>2</sub>α injection in an attempt to determine the onset of estrus. Heifers randomly assigned to produce a female calf were inseminated near the onset of estrus, and heifers randomly assigned to produce a male calf were inseminated approximately 24 hours after the onset of estrus. All heifers not inseminated by 96 hours after PGF<sub>2</sub>α were mass inseminated at that time. Data were analyzed using GLM procedures of SAS. Only 48.1% of pregnancies (n=54) resulted in the birth of a calf of the desired sex. Neither the probe value at AI nor the change in probe value before or after AI affected the percentage of male or female calves. However, when heifers were inseminated ≥ 16 hours after the onset of estrus, there was a tendency (p = .087) to produce more male calves (69%) compared with breeding at estrus onset (36%). These results indicate that a vaginal mucus electrical resistance probe does not enable identification of the optimal time to perform AI to predictably alter calf sex; however,

further research on the timing of insemination to alter calf sex seems warranted.

**Key Words:** Vaginal mucus, Electrical resistance, calf sex ratio

**268 Field evaluation of extended pirlimycin therapy with or without vaccination for *Staphylococcus aureus* mastitis in a dairy herd.** L. Timms<sup>\*1</sup>, M. Kirkpatrick<sup>1</sup>, and P. Sears<sup>2</sup>, <sup>1</sup>*Iowa State University, Ames, IA*, <sup>2</sup>*Michigan State University*.

A field trial was conducted to evaluate the efficacy of extended pirlimycin therapy with or without vaccination for *Staph. aureus* mastitis. Initial aseptic quarter samples of 30 cows showed that 80% of cows and 44% of quarters were infected with *S. aureus*. *S. aureus* infected animals were split into three groups, with an attempt to balance the number of infected cows/quarters in each group. Quarter milk samples for bacteriology, SCC, and other milk components were taken twice prior to treatment and at 14, 32, and 60 d after treatment. All quarters of all cows were treated with pirlimycin (two total tubes 24 h apart, repeated three times, with 48 h in between treatment series). One group received a vaccine that had herd autogenous strains incorporated, and another group received a new trivalent *S. aureus* vaccine (Dr. Phil Sears, Michigan State University). Cows were vaccinated at 14 and 1.5 d before treatment, and 6 d after treatment was initiated. All cows received 5 cc Vital E on vaccination days. Cows/quarters with *S. aureus* in the treatment only (TO), autogenous vaccine (AV), and trivalent vaccine (TV) groups were 11/22, 10/21, and 7/18 cows, respectively. Cure rates at 32 d after treatment were 18%, 38%, and 56% for TO, AV, and TV, respectively. However, quarter SCC of many cured quarters, especially vaccinated cows, were still high at this time. Cure rates at 60 d after treatment were 14%, 33%, and 33%, respectively. Some cows had been dried off or sold so results from six vaccinated cows could not be obtained at 60 d, so their 30-d cure rate was used even though 30-d quarter SCC was high on many of these quarters. Cure rates were 14, 17, and 14% when these six vaccinated, yet high SCC quarters, were excluded from d 60 results. During the trial, milk component analysis showed low milk urea nitrogen across the herd, indicating some protein starving and nutrition problems. This probably played a major role in decreased immunity and ability to cure infections. Cure rates were low for all treatments. Sampling cows at 30 d post treatment when both treatment and vaccination are coupled may not be sufficient time to assess true bacterial cure. Potentially waiting until 60 d post treatment or using quarter SCC was a better cure indicator.

**Key Words:** *Staphylococcus aureus* mastitis, vaccination, pirlimycin

**269 Field trial evaluation of a persistent barrier teat dip for preventing dry period mastitis and as a potential alternative/adjunct to dry cow antibiotic therapy.** L.L. Timms<sup>\*</sup>, *Iowa State University*.

The objectives of this 14-mo natural exposure field trial were to evaluate a novel, self developed persistent barrier teat dip for preventing intramammary infection (IMI) during the early and late dry periods and as a potential alternative/adjunct to dry cow antibiotic therapy. A 2×2 factorial design was used with either right or left side teats dipped, whereas the other side served as controls. One quarter (teat) of each group was dry treated using a commercial antibiotic. Cows were dipped at dry off and 14 d post dryoff. Cows and heifers were dipped approximately 7 to 10 d prepartum and redipped as needed to maintain protection until calving. Duplicate aseptic quarter milk samples were collected at 3 d pre-dry off, dry off, 14 d after dry off, calving, and 3 d post calving to assess IMI status. Data were analyzed using a modified t-test and SAS. A total of 221 animals (78 heifers; 143 cows) and 884 quarters completed this trial. Dipped quarters of heifers showed a 26, 75, 75, and 80% reduction in total, major pathogen (MP), gram negative (G-), and environmental streptococcal (ES) IMI at calving, respectively. Dipped quarters of cows showed 34, 47, 75, and 30% reduction in total, MP, *S. aureus*, and coagulase negative staphylococci (CNS) IMI at calving, respectively. Combined data (cows and heifers) showed a 31, 60, 57, 54, 71, and 22% reduction in total, MP, G-, ES, *S. aureus*, and CNS infections, respectively, at calving ( $P < 0.05$ ). All three treatments provided significant reductions in CNS and total IMI compared to controls at 14 d after dry off, with the antibiotic therapy and dip only groups showing significant reductions ( $P < 0.10$ ) in IMI with major pathogens. No significant differences were detected among treatments for new early dry

period IMI. Dipping of cows at dry off and cows and heifers 10 d prepartum until calving with a persistent barrier teat dip product resulted in significantly lower IMI in the early dry period and at calving compared to controls, with no difference in early dry period IMI between dry cow therapy and dipping. Dipping with a novel persistent barrier dip at dry off and precalving provided a simple, innovative way to prevent dry period mastitis, and may provide a more economical, lower risk approach to dry cow therapy for early dry period IMI prevention.

**Key Words:** Intramammary infection, Dry Period, Persistent Barrier Teat Dip

**270 An investigation of the impact of milk production and important management factors on the process of drying off lactating dairy cows.** R.T. Dingwell<sup>\*1</sup>, K.E. Leslie<sup>1</sup>, Y.H. Schukken<sup>2</sup>, David Kelton<sup>1</sup>, Jan Sargeant<sup>3</sup>, and Leo Timms<sup>4</sup>, <sup>1</sup>*University of Guelph*, <sup>2</sup>*Cornell University*, <sup>3</sup>*Kansas State University*, <sup>4</sup>*Iowa State University*.

Although millions of dairy cows are dried off at the end of their lactation each year, the effect of various management approaches on the efficiency of drying off is not well understood. Factors affecting the rate of udder involution and the speed of formation of the teat canal keratin plug are not well documented. The objectives of this project were to define important management strategies and document their effect on the process of drying off. Currently, 253 cows from four different research herds in the U.S. and Canada have been enrolled in this study. Cows were enrolled 2 wk prior to scheduled dry off date. At that time, a subjective udder involution index was assigned, quarter milk samples were collected, and the teat ends were scored according to standardized criteria. Daily milk weights were recorded from enrollment until the day of dry off. Data from 106 cows on the study have been summarized. The average milk production at the time of enrollment was  $14 \pm 7.7$  kg/d. At the time of dry off 2 wk later, the average daily production had declined to  $8.4 \pm 4.6$  kg. It is clear that considerable variation occurs in the decline of daily milk production. On the day of dry off, milk samples, udder involution index and teat end scores were again collected. Each cow was then examined on a weekly basis for the first 6 wk of the dry period. Teat end lesions, udder involution index, and an assessment of closure of the teat streak canal were assigned each week by the research technician in each herd using previously published methodology. At the end of the first week of the dry period, 52.9% of individual teats remained open. There was a linear decline in both the teat end scores and the percentage of teats open each week. However, after 6 wk of the dry period, 19% of teats still remained open. Within the first week of calving, teat ends were scored, a California Mastitis Test was performed and quarter milk samples were obtained. Factors affecting the rate of mammary involution, teat and closure, as well as the incidence of new intramammary infections, have been investigated.

**Key Words:** Dry off, Milk production, Management

**271 Leptin as a metabolic signal in sows.** C.D. Morrison<sup>\*</sup>, J.S. Seaman, D.H. Keisler, and T.J. Safranski, *University of Missouri - Columbia*.

Leptin, a protein hormone secreted by adipocytes, acts as a metabolic signal potentially regulating growth, reproduction, and metabolism. The objective of the current study was to characterize the secretion of leptin before parturition and at weaning in sows. Lactation imposes significant nutritive and metabolic demands, and it was hypothesized that leptin levels would reflect this demand. Approximately 150 mixed parity sows from a large commercial farm were bled and ultrasounded 2 to 4 d before farrowing (d 111 of gestation; before parturition) and again on the day of weaning (at weaning). Radioimmunoassay was used to determine serum concentrations of leptin. Backfat thickness and loin eye area were determined via real-time ultrasound. Leptin concentrations were lower at weaning than before parturition ( $3.2 \pm .174$  vs.  $4.92 \pm .169$  ng/ml;  $P \leq 0.001$ ). Separate regression analyses of serum concentrations of leptin before parturition and at weaning on back fat thickness and loin eye area on congruent days revealed a linear relationship between leptin and back fat before parturition ( $P \leq 0.001$ ; regression coefficient =  $4.95 \pm 1.17$ ). Loin eye area before parturition and at weaning and backfat thickness at weaning were not related to serum leptin concentrations, even though backfat thickness and loin eye area also decreased during lactation ( $P \leq 0.001$ ). This work demonstrates that leptin levels

are related to body fat in sows prior to parturition, with leptin levels decreasing from parturition to weaning. This decrease may be associated with the change in pregnancy status and/or the nutritive demands of lactation. The lack of relationship between leptin and backfat at weaning may also reflect the influence of factors other than adipose mass on leptin secretion. The impact of reduced serum leptin following lactation is unknown. However, because serum leptin is associated with reproductive performance in other species, post-lactation leptin levels may be a significant metabolic cue influencing subsequent reproductive performance.

**Key Words:** Sow, Leptin, Reproduction

**272 The effects of prepartum and preweaning vaccination of beef cows and calves with a commercially available *Pasteurella haemolytica* vaccine.** L.E. Wankel\*, T.T. Marston, G.L. Stokka, T.G. Rozell, and J.R. Brethour, *Kansas State University, Manhattan*.

The objective of this study was to discover if a *Pasteurella haemolytica* vaccine, administered to beef cows before parturition and to their offspring before weaning, could improve health as well as increase performance in calves between birth and slaughter. In January 1999, multi- and primiparous crossbred cows (n=280), housed at the Western Kansas Agricultural Research Center in Hays, KS, received an injection of *P. haemolytica* vaccine (VAC) or no injection (CON) 3 wk before the onset of the calving season. Three weeks before weaning, calves were blocked by cow treatment and allotted randomly to receive an injection of *P. haemolytica* vaccine (VAC2) or no injection (CON2). Calf treatment groups included VAC/VAC2, VAC/CON2, CON/VAC2, or CON/CON2. The VAC multiparous cows had a greater ( $P < 0.05$ ) titer response for *P. haemolytica* compared to CON cows. However, primiparous cows did not have a titer increase due to vaccination. No difference was recorded in the incidences of preweaning illness or preweaning gain. After weaning, no differences of illness were recognized for any calves or gain for steer calves. The steer calves were slaughtered (average age=467 d, average weight=599 kg) and carcass traits and lung lesion scores were collected. No differences were detected in dressing percentages, yield grades, marbling scores, or back fat. Lung lesion scores also were not different. Body weights of heifer calves were assessed monthly for 3 mo after weaning. Heifer calves reared by VAC cows gained ( $P < 0.05$ ) more weight during the second month after weaning than CON-reared heifers. Calf treatments also had no effect on weight gains of heifers. *Pasteurella haemolytica* vaccine was effective in increasing serum titers in multiparous cows, but not in primiparous cows and had little effect on calf performance or health.

**Key Words:** *Pasteurella Haemolytica*, Beef cows, Titers

**273 Temporal feeding of melengesterol acetate (MGA) to elicit an estrous response in early postpartum beef cows.** J.F. Gleghorn\*, T.T. Marston, and L.E. Wankel, *Kansas State University, Manhattan*.

Multiparous, spring-calving cows (n=39) were used to evaluate the effects of temporal feeding of MGA on progesterone profiles, incidence of short cycles, response to prostaglandin  $F_{2\alpha}$  (PGF), and conception rates. Cows were blocked by calving date and assigned individual allocations of .5 mg of MGAhd-1d-1 for 0 (CONTROL), 2, 4, or 8 d beginning 30 d postpartum while cows grazed native grass pasture and were exposed to calf suckling. Blood was collected at 10 d, 0 d, and daily as cows completed treatment until 60 d postpartum. Serum progesterone ( $P_4$ ) concentrations were determined from blood samples and  $P_4$  profiles were created for individual cows. Cyclic cows (n=8) at treatment initiation were excluded from analysis. Cows were synchronized with a two-shot PGF system and artificially inseminated following standing heat. Bulls were placed with cows 6 d following the second PGF injection. Date of pregnancy was determined by rectal palpation and calving dates. Days to the first transient rise in progesterone differed between 2 d (34.8 d) and 4 d and 8 d, 45.0 and 48.5 d respectively ( $p < .05$ ), but not from CONTROL (38.8 d). Treatment had no effect on Julian date of conception or days to conception following parturition ( $p > .46$ ). The incidence of short cycles diminished with longer MGA treatment ( $p = .28$ ), [CONTROL (91%), 2 d (53%), 4 d (32%), 8 d (0%)]. The greatest response ( $p > .67$ ) to PGF was seen in the 8 d group (89%), followed by CONTROL (73%), 4 d (65%), and 2 d (46%). An overall pregnancy

rate of 92% was achieved. The artificial insemination (AI) rate for non-cycling cows was 52%, and was highest ( $p > .59$ ) for the 2 d treatment (80%), followed by the 4 d (50%), and 8 d and CONTROL (40%). The data suggest that the length of short-term MGA treatment influences the date of first postpartum increase in  $P_4$ . Furthermore, the decreased incidence of short cycles and increase in AI rate suggests that MGA has the opportunity to increase the responsiveness of the postpartum cow to estrous synchronization.

**Key Words:** Beef cow, MGA, Postpartum interval

**274 The effect of limited melengesterol acetate (MGA) feeding on pregnancy rate and postpartum interval in fall and spring calving beef cows.** J.F. Gleghorn\*, T.T. Marston, and L.E. Wankel, *Kansas State University, Manhattan*.

The effects of short-term, prepartum MGA treatment on pregnancy rates and postpartum interval were evaluated on fall and spring calving herds. In trial 1, beginning 30 d prior to the breeding season, multiparous, black baldy, fall calving cows (n = 93) were either fed 0.5 mg of MGAhd<sup>-1</sup>d<sup>-1</sup> for 4 d (TRT; n=44) or fed no MGA (CONTROL; n = 49). Cows grazed common fescue pastures. Pregnancy was determined using ultrasonography 45 d after the 60-d breeding season. Pregnancy rate between TRT (97%) and CONTROL (95%) was not influenced by treatment. Trial 2 consisted of 36 multiparous, spring calving cows. Treatments were identical to Trial 1. Plasma progesterone was used to determine if cows had returned to estrus prior to feeding MGA. Cows grazed native grass pasture. Again, bulls were placed with cows for 60 d. Pregnancy was determined by ultrasonography and rectal palpation 45 d following the breeding season. Pregnancy rates were greater ( $P < 0.05$ ) for TRT (100%) than CONTROL (76%). Analysis of only the anestrous cows (n = 23) revealed a similar difference ( $P > 0.18$ ) in pregnancy rates between TRT (100%) vs. CONTROL (81%) groups. Twenty-nine cows used in this experiment were subjected to MGA treatment the prior year and an analysis of calving interval was performed. The calving intervals ( $P > 0.24$ ) for four MGA treatments of 0, 2, 4, or 8-d duration beginning 30 d prior to the breeding season were: 377, 355, 366, and 371 d, respectively. Results from trial 1 indicated that short-term treatment with MGA had little effect on fall calving cows. In contrast, short-term treatment on spring calving cows increased pregnancy rates. Therefore, MGA may increase pregnancy rates and move late calving cows into an earlier calving season.

**Key Words:** Beef cows, MGA, Calving interval

**275 Fetal mortality as influenced by ovulation rate and uterine capacity in three selected lines of pigs.** R. K. Christenson\* and K. A. Leymaster, *USDA, Agricultural Research Service, U.S. Meat Animal Research Center*.

Uterine capacity as a component trait of litter size is responsive to selection [J Anim Sci 78(Suppl 1):68, 2000]. Embryonic mortality that occurs before d 30 of gestation has been studied extensively, while fetal mortality (after d 30 of gestation) has not been well characterized. The objective was to examine fetal mortality in unilaterally hysterectomized-ovariectomized (UHO) gilts of control (CO), ovulation rate (OR), and uterine capacity (UC) selected lines. Gilts were UHO at 160 days of age, mated to boars of the same lines at second or third estrus, and slaughtered at 105 days of gestation. Number and total weight (combined fetal and placental necrotic tissues) of all mummified fetuses were recorded. In total, 148 CO, 153 OR, and 121 UC litters produced 2923 live and 547 mummified fetuses. Ovulation rate (# of CL) and uterine capacity (live fetuses) for the CO, OR, and UC lines were 14.8 and 6.8, 17.9 and 6.3, and 15.0 and 7.8, respectively. The total number and litter average of mummified fetuses for CO, OR, and UC lines were 193 and 1.3, 250 and 1.6, and 104 and 0.9, respectively. Mummified fetuses were grouped by weight ranging from 0 to 499 g in 50-g increments and  $\geq 500$  g to calculate the frequency of mummified fetuses in each weight class. Across all lines, the lowest weight class (0-49 g) had the greatest frequency of mummies. Chi-square analysis indicated that the frequency of mummified fetuses was greatest in OR, intermediate in CO, and lowest for UC gilts ( $P < 0.01$ ). In conclusion, results suggest that fetal mortality occurs throughout gestation for all three lines but occurs most often during early gestation as indicated by the high frequency of mummified fetuses in the lowest weight class. Thus under crowded

uterine conditions, selection for ovulation rate increased and selection for uterine capacity decreased fetal mortality.

**Key Words:** Swine, Fetus, Mortality

**276 Development of a bovine  $\beta$ -actin probe for ribonuclease protection assays.** S.H. Wu\*, M.P. Murtaugh, D.N. Foster, and B.A. Crooker, *University of Minnesota*.

The  $\beta$ -actin gene is usually considered a constitutively expressed gene and is frequently used as an internal control in ribonuclease protection assays (RPA) to correct for incomplete precipitation and loading of protected fragments and to adjust for variation among gels. Although probes developed from one species can frequently function appropriately for other species, sequence discrepancies between the probe and targeted mRNA can result in single stranded regions which are digested by RNase. This decreases probe stability and increases assay variation. Therefore, our objective was to develop a bovine specific  $\beta$ -actin RPA probe. A search (GenBank) indicated the bovine  $\beta$ -actin 3' untranslated region (UTR) sequence was not available so the ovine  $\beta$ -actin 3' UTR sequence (GenBank, GI: 2182268) was used to develop RT-PCR oligonucleotide primers. These primers (forward, 5'-CGGACTGTTAGCTGCGTTAC-3', and reverse, 5'-TGAAGGTCACAGCATGGTTG-3') encompassed nucleotides 1216 - 1509 of the ovine sequence and produced about a 500 base pair (bp) product with bovine RNA. This putative bovine  $\beta$ -actin 3' UTR was sequenced and bovine specific (forward 5' -GAATTCATGCTTCTAGGCGGACTG-3' and reverse 5'-AAGCTTAGCCATGCCAATCTCATC-3') RT-PCR oligonucleotide primers were developed. Restriction sites (EcoRI and HindIII) at ends of this RT-PCR product were used to facilitate directional cloning into pBluescript II SK+. The vector was transformed into E. coli DH5 $\alpha$  competent cells, purified and sequenced. Results indicated the  $\beta$ -actin 3' UTR insert was 89 bp and was similar in sequence to  $\beta$ -actin 3' UTR from other species. RPA results indicated the  $\beta$ -actin RNA probe transcribed from this template was able to generate the expected 89 bp nucleotide protection fragment. There was no interaction between the  $\beta$ -actin probe and probes for other targeted genes. We conclude that a bovine specific  $\beta$ -actin antisense internal control template for RPA has been successfully developed.

**Key Words:** Bovine  $\beta$ -Actin, Ribonuclease Protection Assay, Antisense Probe

**277 Characterization of serum hormone profiles of growing heifers implanted with estrogenic or androgenic implants.** D. A. Blasi<sup>1</sup>, D. M. Hendricks<sup>2</sup>, G. L. Kuhl<sup>1</sup>, J. S. Drouillard<sup>1</sup>, M. F. Spire<sup>1</sup>, and J. E. Minton<sup>1</sup>, <sup>1</sup>Kansas State University, <sup>2</sup>Clemson University.

A 147-d drylot study was conducted to determine the growth performance patterns and serum hormone profiles of stocker heifers implanted with androgenic or estrogenic growth promotants. Forty eight previously nonimplanted crossbred beef heifers, averaging 180 kg, were assigned to three treatments: 1) non-implanted control (NC), 2) Revalor-G (REV-G) and 3) Synovex-H (SYN-H). Heifers were weighed and samples of serum were obtained at d 0, 2, 7, 14, 21, 42, 63, 84, 105, 126 and 147. Daily gains of REV-G and SYN-H heifers were similar to NC during the first 21 d. Thereafter, heifers in both treatments gained 10 to 27% faster than NC during the next five 20-d periods. Subsequently, SYN-H heifers gained numerically faster than REV-G or NC during the final two weigh periods. Serum estradiol concentrations were increased by d 2 in REV-G ( $P<0.05$ ) and SYN-H ( $P<0.01$ ) heifers relative to NC. However, concentrations of estradiol in SYN-H heifers were greater ( $P<0.05$ ) than those of REV-G and NC on d 7, 14, 42, and 105. Because only REV-G contains trenbolone acetate, none was detected in NC and SYN-H heifers, but TBA serum concentrations in REV-G heifers were increased on d 2 ( $P<0.001$ ), 4 ( $P<0.05$ ) and 63 ( $P<0.001$ ). Only SYN-H contains testosterone, and serum testosterone in SYN-H heifers peaked by d 63 and remained higher through d 147. Throughout the study, progesterone was higher in NC than in SYN-H or REV-G heifers suggesting that the implanted steroids may have reduced ovarian progesterone secretion. Our results indicate that release patterns of trenbolone, testosterone, and estradiol from REV-G and SYN-H implants were essentially complete by 84 d and 126 d, respectively, after implantation.

**Key Words:** Growth implants, Serum hormones, Heifers

**278 Ultrasonographic evidence of luteal-like tissue for determination of treatment in dairy cows with follicular cysts.** C.J. Johnson\*, G.S. Frazer, T.E. Wittum, P.J. Rajala-Schultz, R.W. Meiring, D.W. Shaw, and J.S. Ottobre, *The Ohio State University*.

The objective of this study was to investigate retrospectively the efficacy of basing treatment of dairy cows with ovarian follicular cysts (FCs) on the presence of luteal tissue as determined via ultrasonography (i.e., luteal-like tissue). Ovarian ultrasonography and reproductive records ( $n=68$ ) were used from a previously reported study. These data were collected from dairy cattle with naturally occurring FCs on seven dairies in Ohio. New luteal-like tissue (LLT), detection of estrus and ovulation (i.e., follicle replaced with luteal tissue) within 14 d of treatment were used as end points in this analysis. Cows ( $n=49$ ) were divided into two groups on d 1. Cows in group 1 (no LLT;  $n=36$ ) and group 2 (LLT;  $n=13$ ) received GnRH (100 $\mu$ g). On d 14, cows ( $n=20$ ) that still had a FC and were not inseminated were divided further into two groups. Cows in group 3 (no LLT;  $n=7$ ) received GnRH (100 $\mu$ g). Cows in group 4 (LLT;  $n=13$ ) received PGF<sub>2</sub> $\alpha$  (25 mg). Fisher's exact test was used to make end point comparisons among groups (1 vs 2, 3 vs 4, 2 vs 4). When cystic cows were treated with GnRH regardless of the presence of luteal tissue, observed estrus (17% vs 15%), ovulation (14% vs 15%), and new LLT development (81% vs 85%) within 14 d of treatment were not different between groups 1 and 2. A greater percentage of cystic cows that received PGF<sub>2</sub> $\alpha$  with LLT (Group 4) displayed estrus (77% vs 43%;  $P=0.17$ ), ovulated (54% vs 29%;  $P=0.37$ ), and formed new LLT (77% vs 57%;  $P=0.61$ ) than cows without LLT that received GnRH (Group 3). More FC cows with LLT present that were treated with PGF<sub>2</sub> $\alpha$  (Group 4; 77%) displayed estrus than cystic cows with LLT present that received GnRH (Group 2; 15%,  $P<0.01$ ). In addition, a trend occurred for more ovulations in group 4 than group 2 (54% vs 15%). However, there was no difference in the formation of new LLT within 14 d for group 4 and group 2 (77% vs 85%). In conclusion, this study demonstrated that PGF<sub>2</sub> $\alpha$  may be a more appropriate treatment to increase subsequent estrus in cows with ovarian FCs if luteal-like tissue is present. Therefore, using ultrasonography to detect luteal-like tissue at the time of diagnosis and treatment may provide an earlier opportunity for breeding, but further investigation is needed to determine pregnancy outcomes.

**Key Words:** Follicular Cysts, Bovine, Ultrasound

**279 Reproductive efficiency of dairy cows is associated negatively with concentrations of liver lipids in the postpartal period.** G. Bobe\*<sup>1</sup>, B. N. Ametaj<sup>1</sup>, D. C. Beitz<sup>1</sup>, and J. W. Young<sup>1</sup>, <sup>1</sup>Iowa State University, Ames, IA.

It has been reported that ketotic cows have lower reproductive efficiency than non-ketotic cows. Because lipid accumulation in liver precedes ketosis, we tested whether lipid accumulation in liver is also associated with reproductive performance. Liver lipid concentrations in 38 multiparous Holstein cows were determined eight times in the first 6 wk after calving and compared with reproductive traits such as days to first estrus, days to first service, days open, number of services per conception, and number of ovarian cysts. Cows with liver lipid concentrations  $>10\%$  wt tissue showed first estrus and were inseminated at similar times as cows with lower liver lipid concentrations ( $P>0.10$ ). However, they conceived later ( $P<0.05$ ) and had a greater number of ovarian cysts ( $P<0.10$ ). Cows with chronic mastitis conceived later ( $P<0.05$ ) than cows without mastitis, suggesting that liver lipid is not the only determinant of reproductive efficiency of dairy cows. We concluded that preventing lipid accumulation in the liver in the postpartal period is important to achieve greater reproductive efficiency after calving. (Partly supported under CREES-USDA agreement 99-35005-8576).

**Key Words:** Dairy Cows, Liver Lipid, Reproduction

## RUMINANT NUTRITION AND FORAGES

**280 Efficacy of pelleted wheat midds amended with food waste as a protein and energy substitute for beef cows.** P.M. Walker\*, *Illinois State University, Normal.*

Seventy-eight beef cows in the third trimester were blocked by parity (first parity, and 2 or more parities), then stratified to eight treatment pens according to body condition score, subject to variation in body weight to evaluate the efficacy of replacing a portion of the diet with a pelleted mixture of wheat midds and human food waste (PFW). The duration of the trial was 131d. The trial was terminated following a timed insemination to a synchronized estrus. Control cows (CTL) were fed a corn silage-shelled corn-soybean meal based diet according to NRC estimates. Treatment cows (TRT) received similar diets except PFW replaced all of the shelled corn and soybean meal. PFW contained 75% wheat midds and 25% ground food waste on a DM basis. The food waste was obtained primarily from grocery stores and contained 75% moisture prior to mixing with wheat midds, pelleting and subsequent dehydration. Chemical analysis found PFW to contain  $95.4 \pm 1.1\%$  DM,  $18.7 \pm 2.5\%$  CP,  $7.8 \pm .2\%$  EE,  $12.0 \pm 1.2\%$  ADF,  $5.4 \pm .1\%$  ASH,  $.03 \pm .01\%$  Ca,  $.97 \pm .17\%$  P and  $.22 \pm .09\%$  Na. Ether extract trended higher ( $P < 0.1$ ) for TRT diets than CTL diets. Percent P and Na were higher ( $P < 0.05$ ) for TRT diets than CTL diets comparing  $.46 \pm .07$  vs.  $.29 \pm .03$  and  $.11 \pm .04$  vs.  $.04 \pm .02$ , respectively. Free choice mineral consumption trended higher ( $P < 0.10$ ) for CTL than TRT. No differences ( $P > .05$ ) in starting wts., ending wts., wt. changes, nor in starting, ending or change in body condition scores were observed between TRT and CTL. No differences ( $P > .05$ ) in calf birth wt. nor calving ease scores were observed. Percent calves born live was higher ( $P < 0.05$ ) for TRT than CTL. TRT consumed approximately 3.0 kg of PFW:d. CTL consumed approximately .64 kg of corn and 1.1 kg of soybean meal per day. Diets containing PFW saved 28.58 to 34.21:d in feed cost resulting in an estimated value per kg for PFW ranging from 9.75 to 10.76:kg. The data of this trial suggests that PFW can serve as a replacement for shelled corn and soybean in a corn silage based diet for beef cows.

**Key Words:** Food Waste, Feedstuff, Cows

**281 Influence of concentrated separator by-product (CSB) on intake, digestion, and nitrogen balance in wether lambs.** S. M. Shellito\*, J. S. Caton, C. Navanukraw, H. B. Encinias, E. R. Loe, and M. L. Bauer, *North Dakota State University, Fargo.*

Five wether lambs (44.1  $\pm$  1.5 kg) were used in a 5 x 5 Latin square to evaluate effects of CSB on intake, digestion, and N balance. Basal forage was 7.7% CP. The first three treatments (TRT) were 0, 10, and 20% CSB mixed as a proportion of diet DM. Treatment 4 included 10% CSB offered separately and pair fed with TRT 2. Treatment 5 (urea control) consisted of a urea solution added to forage with equal N compared with TRT 2. Experimental periods were 17 d with the last 7 d used for collections. Contrasts were linear and quadratic effects of CSB (0, 10 and 20% CSB for, TRT 1, 2, and 3 respectively), 10% CSB mixed compared with 10% CSB fed separately (TRT 2 vs 4), and urea vs 10% CSB mixed with basal forage (TRT 5 vs 2). Forage and total intake (g/d) increased (linear;  $P < .01$ ) as CSB increased (813 and 813, 981 and 1090, and 1015 and 1256, for TRT 1, 2, and 3, respectively). Forage and total intake were lower ( $P < .04$ ) in 10% CSB fed separate and urea control compared with TRT 2 (10% CSB mixed). Feeding 10% CSB separately resulted in similar ( $P > .10$ ) DM (52.9 vs 52.3  $\pm$  1.5%) and OM (50.6 vs 54.3  $\pm$  1.9%) digestibility compared with TRT 2. Increasing CSB increased (linear;  $P < 0.03$ ) DM, OM, apparent N digestion, and water intake. Nitrogen balance increased (linear;  $P < 0.01$ ) with CSB (0.57, 0.53, and 2.88 g for 0, 10, and 20% CSB, respectively). Feeding CSB separately resulted in greater N balance compared with CSB mixed with forage ( $P < 0.01$ ; 2.73 and 0.53 g, respectively). Urea had similar ( $P = 0.3$ ) N balance compared with TRT 2. Nitrogen balance as a percent of N intake had similar results as N balance (g/d); means were 3.2, 2.7, 12.6, 17.1, -2.6  $\pm$  3.4% for TRT 1, 2, 3, 4, and 5 respectively. Data suggests that CSB increases intake, digestion, and N balance when offered to lambs fed mature grass hay. In addition, effects of CSB on intake and digestion are not completely explained by N addition. Mixing CSB with basal forage improves intake and digestion.

**Key Words:** Concentrated Separator By-Product, Intake, Nitrogen Balance

**282 Bread by-product for growing beef steers: Effects on steer performance and by-product variability.** W.W. Dvorak\*, M.L. Bauer, G.P. Lardy, and E.R. Loe, *North Dakota State University, Fargo.*

Forty-four Angus cross beef steers (303.2  $\pm$  0.4 kg initial BW) were used to compare the effects of substituting bread by-product for rolled corn in a roughage-based grower diet. Steers were stratified by weight and assigned randomly to treatment (11 steers/pen; 2 pens/treatment). Diets contained 40% corn or bread by-product, 30% alfalfa hay, 20% corn silage, 6% supplement, 4% concentrated separator by-product (CSB), 27.5 mg/kg monensin and were fed for 84 d. Diets were formulated to meet ruminal degradable and metabolizable protein requirements (0.4% feather meal and 0.1% blood meal; DM basis) based on 1996 NRC Nutrient Requirements of Beef Cattle model and contained 13.8% and 14.1% CP, respectively for corn and bread diets, 0.6% Ca, and 0.3% P. The bread by-product contained (mean  $\pm$  SD; n = 7) 70.2  $\pm$  1.6% DM, 15.9  $\pm$  0.8% CP, and 4.9  $\pm$  3.0% ether extract. Dry matter intake was calculated weekly. Steers were weighed twice during the trial and daily gain and feed efficiency were calculated. Steers were limit-fed a common diet 5 d prior to initial and final 3-d average weight. Corn-fed steers had greater dry matter intake during the first 35 d (9.2 vs 8.2  $\pm$  0.1 kg/d,  $P = 0.003$ ) compared with the bread-fed steers. There was no difference in average daily gain (1.46  $\pm$  0.01,  $P = 0.29$ ) between steers fed the two diets. Bread-fed steers had greater feed efficiency during the trial (155.2 vs 139.3  $\pm$  3.1 g/kg,  $P = 0.07$ ) compared with the corn-fed steers. Dietary  $NE_g$  was greater for bread than corn diets (1.19 vs 1.07  $\pm$  0.02 Mcal/kg,  $P = 0.05$ ). Apparent  $NE_g$  values for bread and corn were 1.64 and 1.29 Mcal/kg, respectively. Bread is more energy dense than corn and is a viable alternative for grain in growing beef cattle diets.

**Key Words:** Steers, Bread By-Product, Net Energy

**283 Self-fed wheat middlings in backgrounding diets for beef heifers.** T. Gilbery\*<sup>1</sup>, G. Lardy<sup>1</sup>, B. Kreft<sup>2</sup>, J. Dhuyvetter<sup>3</sup>, and M. Bauer<sup>1</sup>, <sup>1</sup>North Dakota State University, Fargo, <sup>2</sup>Streeter, <sup>3</sup>Minot.

Wheat middlings are relatively high in CP compared with other cereal grains used in North Dakota backgrounding operations. Wheat middlings contain higher concentrations of fiber than corn or barley, making them favorable for self-feeding. One hundred seventy-one crossbred heifers (282  $\pm$  33 kg initial BW) were used in a backgrounding study to evaluate self-fed vs mixed diets containing wheat middlings. Variables of interest included dry matter intake, average daily gain, and feed efficiency, two dietary treatments were used: 1) totally mixed ration (TMR) and 2) self-fed wheat middlings-based diet. The TMR contained (DM basis) 48.25% grass hay, 48.25% wheat middlings, and 3.5% supplement. The self-fed diet consisted of ad libitum chopped grass hay fed in a fence line bunk and self-fed wheat middlings. The self-fed wheat middlings were fed in a portable creep feeder and contained (DM basis) 93.24% wheat middlings, and 6.76% supplement. Crude protein concentrations of feedstuffs (DM basis) were grass hay, 7.82%; wheat middlings, 18.33%; and supplement, 9.86%. Both diets were formulated to provide adequate calcium to maintain a Ca:P ratio of 1.5:1. Cattle were weighed every 28 days. Feed ingredients were sampled weekly throughout the trial. Daily records of feed offered were recorded. Performance data was analyzed using the GLM procedure of SAS. There was no significant difference between treatments for: intake (8.54  $\pm$  0.18 kg;  $P = 0.78$ ), feed efficiency (45  $\pm$  2 g/kg;  $P = 0.64$ ), average daily gain (0.83  $\pm$  0.04 kg;  $P = 0.47$ ), and hay consumption (4.26  $\pm$  0.13 kg  $P = 0.51$ ). Wheat middlings consumption was higher for TMR vs self-fed diet (4.29 vs 3.9 kg;  $P = 0.01$ ). Feeding wheat middlings may be a practical way to background beef cattle at moderate rates of gain. The self-fed backgrounding method may be particularly useful for producers with smaller herds or off-farm employment because of lower equipment investment and lower labor inputs.

**Key Words:** Wheat Middlings, Backgrounding, Heifers

**284 Effect of feeding hull-less oats with varying levels of rumen-undegradable protein on performance of early lactation Holstein cows.** D.B. Carlson\*, J.W. Schroeder, D.E. Schimek, M.S. Laubach, W.L. Keller, and C.S. Park, *North Dakota State University, Fargo.*

Hull-less oats (HO) are a relatively new crop with a unique nutrient composition of approximately 18% crude protein (CP) and 10% fat. The objectives of this research were to examine the effects of HO, with two levels of rumen-undegradable protein (RUP), on lactation performance, milk composition, blood metabolites, and rumen parameters of early lactation cows. Twelve multiparous Holstein cows averaging 644 kg of body weight and 58 d in lactation were randomly assigned to one of four treatments in a triplicated 4 X 4 Latin square design. Treatments consisted of 1) corn-barley (CB) based, 2) CB with additional RUP, 3) HO based, and 4) HO with additional RUP. Treatments were formulated to contain 1.67 Mcal net energy for lactation per kg of dry matter and 17.2% CP. The supplemental RUP treatments contained an additional 6% RUP (percent of CP). Cows were housed individually in tie stalls and fed twice daily for 16 wk. Dietary dry matter intake (DMI), milk yield, and milk composition was determined during the last week of each experimental period. Rumen and blood samples were also collected at this time. Milk yield, DMI, ruminal pH, milk fat, milk protein, and milk lactose did not differ between treatments. HO inclusion increased milk urea nitrogen, serum triglycerides, and blood urea nitrogen ( $P < 0.01$ ), irrespective of additional RUP. HO inclusion tended to decrease ruminal ammonia ( $P < 0.05$ ) at 3 h post-feeding. Treatment had no effect on serum insulin or non-esterified fatty acids. HO appears to be a suitable replacement for corn-barley grain in lactating cow diets.

**Key Words:** Hull-less Oats, Early Lactation, Rumen-undegradable Protein

**285 Carbohydrate composition of commonly used feedstuffs in the Midwestern US.** D. Kleischmit\* and R. Grant, *University of Nebraska, Lincoln.*

There are a variety of feedstuffs for producers in the Midwestern US to choose from; many of these feeds differ substantially in carbohydrate composition, so it is important that these carbohydrate fractions are measured to properly formulate a ration. Twenty-three commonly used feeds were analyzed for neutral detergent soluble carbohydrates using the University of Florida Method for Carbohydrate Analysis (Hall, 1999). Four different categories of feedstuffs were analyzed: wet forages, dry forages, concentrates, and by-products. The range in starch content for the four types of feedstuffs was: 42.2 to 0.8%, 2.4 to 0.9%, 65.3 to 0.4%, and 10.0 to 0%, respectively. The total 80% ethanol-soluble carbohydrate (TESC) analysis for mono- and oligosaccharides was: 4.1 to 1.1%, 5.6 to 0%, 13.9 to 1.1%, and 7.0 to 0.0%, respectively. The organic acid (OA) content range was: 6.5 to 2.4%, 10.7 to 0%, 5.4 to 0%, and 6.7 to 0.2%, respectively. The neutral detergent soluble fiber (NDSF) content range was: 14.1 to 5.0%, 16.4 to 2.9%, 9.3 to 0%, and 33.9 to 0%, respectively. The NDF composition range was: 58.3 to 33.7%, 89.1 to 59.1%, 63.1 to 15.5%, and 69.0 to 45.5%, respectively. The CP range was: 21.5 to 8.0%, 30.0 to 2.1%, 51.4 to 8.7%, and 32.8 to 11.1%, respectively. Using these values for the neutral detergent soluble carbohydrates will allow nutritionists to formulate rations that more adequately meet the cow's nutritional requirements.

**Key Words:** Carbohydrate, Neutral Detergent, Solubles

**286 Response of feedlot steers to diets containing bloodmeal and choice white grease.** J. W. Lehmkuhler\*, E.E.D. Felton, C.J. Fu, S. Weber, and M. S. Kerley, *University of Missouri.*

Sixty-nine continental crossbred steers (initial BW = 286 kg) were used in a 2x2 factorial arrangement to test the effects of added bloodmeal (BM) and choice white grease (CWG). The study was divided into two periods for a combined length of 200d. During the first 69d, diets consisted of high moisture corn (HMC), dry corn, soybean hulls, corn silage, and a soybean meal based supplement with BM at 10% of the diet DM for respective treatments. CWG was added to corresponding treatments at a level of 5% of the diet DM. During the remaining 131d, diets were similar to period one with dry corn replacing HMC while the level of BM was lowered to 5%. Steers were implanted with Revalor S<sup>®</sup> and treated dermally with ivermectin 5d prior to initiation and then reimplanted on d 69. Steers were weighed on two consecutive days prior to feeding at the

initiation and end of each period. The diets averaged 61.9% and 63.8% DM for period 1 and 2. CP ranged from 13.1% to 21.5% and 12.7% to 16.5% for the early and late finishing phases while NDF and ADF values were 18.4 to 21.9% and 11.8 to 14.0%, respectively. Pen average weights were similar at the beginning and termination of each period. Average weight at the end of the 200d study was 598 kg. Addition of BM and/or CWG did not alter DM intake, ADG, FG, or GF ( $P > .10$ ) during either period and no interactions existed. ADG were between 1.42 to 1.77kg/d and 1.42 to 1.53 kg/d for the early and late finishing periods. Gain efficiencies were 0.20 to 0.22 and 0.15 to 0.17 for period 1 and 2, respectively. These data suggest that the addition of BM and/or CWG does not alter the performance of feedlot steers. Further, correctly balanced traditional feedlot diets are sufficient to support moderate performance of finishing cattle.

**Key Words:** Ruminant, Undegradable Intake Protein, Lipid

**287 Effects of two protein supplementation systems on performance and carcass characteristics of feedlot steers.** L.R. Miller\*<sup>1</sup>, A. DiCostanzo<sup>1</sup>, C.M. Zehnder<sup>1</sup>, G.C. Lamb<sup>2</sup>, and L. Smith<sup>3</sup>, <sup>1</sup>University of Minnesota, St Paul, <sup>2</sup>North Central Research and Outreach Center, Grand Rapids, <sup>3</sup>Northwest Research and Outreach Center, Crookston.

Results from a previous CP utilization model fitted to steers weighing >340 kg indicated that the CP requirement for optimum growth and efficiency under an aggressive implant strategy was 1250 g/hd/d. A finishing study was conducted using 226 medium-frame Angus and Angus-cross steers (initial BW, 297 kg) to determine if this requirement would apply to lighter, younger cattle. Steers were randomly assigned to one of two dietary treatments for a 145-d finishing trial. Treatments consisted of supplementing the diet to achieve a constant percentage of dietary CP (CPP; 13.9% dietary CP), or constant CP intake (CPI; 1250 g CP/hd/day). Diets were formulated to contain .61 Mcal NEg/lb DM, .6% Ca and .3% P, and were offered once daily ad libitum. Initial weights were the average of two consecutive day weights and were taken after withdrawing feed and water for 14 h. Final weight was estimated from hot carcass weight divided by a dressing percentage of 62%. Steers were implanted with Revalor-S on d 1 and d 70 of trial. By design, diet CP % and daily CP intakes were greater ( $P = .0001$ ) for CPP versus CPI treatments (13.95 vs 12.54% CP and 1426 vs 1177 g/d, respectively). There was no difference ( $P > .10$ ) in ADG (1.76 vs 1.80 kg/d for CPI vs CPP treatments, respectively). Steers in the CPI treatment consumed less ( $P = .0001$ ) total DM than the CPP treatment (9.36 and 10.20 kg/d, respectively). Dry matter required/kg gain was less ( $P = .0003$ ) for steers in the CPI than the CPP treatment (5.33 and 5.69 kg DM/kg gain, respectively). No differences ( $P > .10$ ) were detected for marbling, yield grade, back fat, ribeye area, or kidney, pelvic and heart fat depot between treatments. Results indicate that feeding 1250 g CP/hd/d resulted in no detrimental effects on performance or carcass characteristics of lightweight young steers under aggressive implant strategies.

**Key Words:** Steers, Performance, Crude Protein

**288 Influence of implant strategy and supplemental undegradable intake protein on growth and carcass characteristics of steers.** P. A. Ludden\*, D. L. Hixon, and W. J. Means, *University of Wyoming, Laramie.*

One hundred twelve Gelbvieh-Angus steers were used in a 158 d experiment to determine if implant strategy and supplemental undegradable intake protein (UIP) interact to influence growth and carcass characteristics of beef steers. Steers were blocked by initial BW ( $333 \pm 12.7$  kg) and randomly assigned to one of 16 pens (7 steers/pen). Steers were fed either a 13.1% CP basal ration (74.9% cracked corn, 15% chopped bromegrass hay, and a soybean meal/urea-based supplement), or the basal ration plus 150 g/d supplemental UIP from feather meal and blood meal (67:33, N basis). All steers were implanted with an estrogenic implant (Synovex-S<sup>®</sup>; Fort Dodge Animal Health) 40 d before the study, and were reimplanted at d 42 of the trial with either an estrogenic implant (E; Synovex-S) or an estrogenic + trenbolone acetate implant (E+TBA; Synovex PLUS<sup>®</sup>). No implant x UIP interactions ( $P \geq 0.11$ ) were noted for any of the variables measured. Steers given E+TBA gained faster at a similar DMI to those receiving E only, resulting in improved efficiency. Supplemental UIP depressed DMI, resulting in decreased ADG but no change in efficiency. Dressing % and

longissimus muscle area were unaffected ( $P \geq 0.10$ ) by treatment. Steers given E+TBA had heavier carcasses and 12<sup>th</sup> rib fat depth than those receiving E only, but otherwise similar carcass characteristics. Supplemental UIP decreased carcass weight, 12<sup>th</sup> rib fat depth, yield grade, marbling score (small = 1000), average quality grade (high select = 4), and % of carcasses grading choice or higher compared to those fed the basal ration only. Supplemental UIP may not be required to enhance the growth or carcass characteristics of steers given E+TBA.

Item	E	E+TBA	E	E+TBA	SEM	P<	Implant
	0 UIP	0 UIP	150 UIP	150 UIP			
ADG, kg/d	1.60	1.74	1.47	1.65	.05	.042	.008
DMI, kg/d	12.41	12.34	10.99	11.51	.40	.015	NS
kg gain/ 100 kg DMI	12.93	14.29	13.45	14.15	.32	NS	.007
Hot carcass, kg	371.7	384.4	361.9	375.4	3.65	.009	.001
12 <sup>th</sup> rib fat depth, mm	13.03	13.94	10.40	12.44	.587	.003	.011
Yield grade	3.30	3.33	3.15	3.24	.038	.001	NS
Marbling score	1041.5	1018.9	990.4	1004.1	12.5	.008	NS
Quality grade	4.78	4.54	4.11	4.37	.162	.010	NS
% Choice or higher	62.7	58.4	26.0	49.3	.096	.016	NS

**Key Words:** Implants, Undegradable Intake Protein, Beef Cattle

**289 Evaluation of Ralgro<sup>®</sup> during the stocker period on pasture and feedlot performance of Mexican crossbred steers.** D. A. Blas<sup>1</sup>, S. I. Paisley<sup>1</sup>, G. L. Kuhl<sup>1</sup>, M. L. Dikeman<sup>1</sup>, J. Higgins<sup>1</sup>, G. L. Huck<sup>1</sup>, T. B. Farran<sup>1</sup>, J. J. Sindt<sup>1</sup>, S.P. Montgomery<sup>1</sup>, and C. Birkelo<sup>2</sup>, <sup>1</sup>Kansas State University, <sup>2</sup>Schering-Plough Animal Health.

A large scale pasture/feedlot field study was conducted to evaluate the effects of a single Ralgro<sup>®</sup> implant administered during the stocker phase on steer grazing performance and subsequent feedlot and carcass merit. Two thousand seven hundred sixty-four steers of Mexican origin, averaging 204 kg, were assembled previously in Texas and shipped to Kansas where they grazed on three intensive-early-stocked Flint Hills pastures. The steers on each pasture were individually weighed and assigned randomly to a non-implanted control group or administered a Ralgro<sup>®</sup> implant (RAL). RAL steers gained significantly faster (10.5 kg;  $P < .01$ ) than controls during the 82 to 93 d grazing phase. Steers from each pasture were shipped to a commercial feedlot in southwestern Kansas where they were implanted with a single Component E-S, sorted into either light- or heavy-weight pens and fed for 127 to 197 d. Control steers gained faster ( $P < .01$ ) during the feedlot phase. However, RAL steers possessed higher cumulative weight gains throughout the pasture and feedlot phases ( $P < .01$ ) and required three less days on feed ( $P < .05$ ). There were no significant treatment differences for marbling, fat thickness, ribeye area, KPH or yield grade. There was a significant decrease ( $P < .05$ ) in the quality grade of RAL steers that was related to a higher incidence ( $P < .001$ ) of steers with B and C carcass maturities. Previously published pasture/feedlot studies have demonstrated that the positive growth benefits obtained with pasture implants generally are retained through the finishing phase, provided sufficient hormonal stimulation is maintained throughout the feeding period by a feedlot implant program designed to optimize finishing performance and carcass merit. Thus, it is probable that the single estrogenic implant used in the 127 to 197 d feedlot phase was insufficient to optimize terminal performance and maintain the relative body weight differences between implant treatments that were created during the pasture phase.

**Key Words:** Implantation, Steers, Pasture

**290 The effect of integrating pasturing systems into cattle finishing programs and affect on meat quality.** T. A. Williams\* and M. P. Hoffman, Iowa State University.

A 2-year study involving 84 fall-born and 28 spring-born calves in year one and 116 fall-born calves in year two of similar genotypes was conducted. Fall-born calves were started on test in May and spring-born calves in October. Seven treatments were imposed in year 1: 1) fall-born

calves direct to feedlot; 2 and 3) fall-born calves, cool season pasture with or without ionophore then to feedlot at end of July; 4 and 5) fall-born calves, cool season pasture with or without ionophore then to feedlot at end of October; 6 and 7) spring-born calves, cool season pasture with or without ionophore then to feedlot at end of October. Four treatments all receiving ionophores were imposed for year 2: 1) direct to feedlot; 2) cool season pasture then to feedlot at end of July; 3) cool season pasture then to feedlot at end of October; 4) cool season pasture until July, followed by warm season grass until middle of August, cool season pasture until the end of October, and then to feedlot. Rotationally grazed cool season grass consisted of smooth bromegrass and warm season grass consisted of switchgrass. The feedlot diet consisted of an 82% concentrate diet containing corn, alfalfa hay, a protein, vitamin and mineral supplement containing ionophore and molasses. When steers averaged 522 kg (year 1) and 545 kg (year 2) they were processed into beef. In year two steaks from direct to drylot cattle contained the highest moisture and lowest percentage of lipids ( $P < .05$ ). Warner Bratzler shear force values and sensory panel evaluations for tenderness were not affected by treatments. In year one flavor intensity was lowest ( $P < .05$ ) for steaks derived from cattle that were on pasture the longest and received an ionophore. Inclusion of ionophores for cattle on pasture did not influence tenderness, juiciness, and flavor. Results of this study indicate that steer calves placed on cool and warm season pastures prior to being finished in drylot, can produce carcasses with acceptable meat eating qualities.

**Key Words:** Cattle, Pasture, Feedlot, Ionophore, Meat Quality

**291 Effects of forage type on intake, digestion, and in situ rate of NDF and CP disappearance in beef steers.** J. E. Leonard, M. L. Bauer, V. I. Burke, T. C. Gilbery, G. P. Lardy, and J. S. Caton\*, North Dakota State University, Fargo.

Four ruminally and duodenally cannulated beef steers (419–33 kg) were used in a 4 x 4 Latin square to evaluate the effects of forage type on intake, digestion, and rates of NDF and CP disappearance. Diets were alfalfa (ALF), brome (BRO), cornstover (CST), and native grass hay (NGH). Experimental periods were 21 d with 12 d adaptation to diet before collections began. Total DM and OM (g/kg BW) intake were highest ( $P < 0.01$ ) in ALF (19.8 and 17.7), lowest in CST (6.6 and 6.2) and intermediate in BRO and NGH. Total tract digestibility of DM, OM, NDF, and ADF were unaffected ( $P > 0.10$ ) by forage type. This is likely because of differing intakes and rates of passage among treatments. Total apparent CP digestibility was lower ( $P < 0.10$ ) in CST (0.3%) compared with other treatments (69.3, 51.4, and 44.6 % for ALF, BRO and NGH, respectively). In situ rate of NDF digestion (%/h) was faster ( $P < 0.01$ ) in ALF (8.8) than in BRO (4.2), CST (3.3) and NGH (3.1). Forage type did not affect ( $P > 0.01$ ) lag of in situ NDF digestion. Readily degradable forage CP (Fraction A; % of CP) was highest ( $P > 0.01$ ) for CST (47.2), intermediate for ALF and BRO (39.6 and 32.9, respectively) and lowest for NGH (28.6). Slowly degradable forage CP (Fraction B; % of CP) was lower ( $P < 0.01$ ) in CST (37.6) than in ALF, BRO, and NGH (55.7, 50.8, and 51.4, respectively). In situ rate of CP digestion (%/h) differed ( $P < 0.01$ ) among treatments, and was 9.7, 3.5, 1.0, and 2.2–0.3 for ALF, BRO, CST, and NGH, respectively. These data suggest that forage type influences intake and rate of in situ NDF and CP disappearance.

**Key Words:** Forage, Intake, Digestion Rate

**292 Effect of starch, fiber, or degradable intake protein (DIP) supplementation on NDF and ADF digestibility by heifers consuming fescue hay.** M. L. Linville\*, K. C. Olson, and J. E. Williams, University of Missouri, Columbia.

Holstein heifers (n = 20; BW = 270 kg) were used in three randomized complete block experiments to determine the effects of various supplements on digestibility of low-quality fescue hay-based diets. Heifers were restrained in individual tie-stalls and fed fescue hay (*Festuca arundinacea* Shreb.; (8.7% CP, 39.7% ADF) ad libitum. In trial 1, heifers were fed supplemental DIP at 0, .05, .10, .15, or .20% BW/d. Soybean meal (53.3% CP, DIP = 65% of CP) was used to deliver DIP. Total tract digestibility of NDF (TNDFD) was unaffected ( $P > .10$ ) by supplemental DIP. Conversely, total tract ADF digestibility (TADFD) tended to increase in quadratic fashion ( $P = .07$ ) with increasing supplemental DIP. In trial 2, heifers were fed supplemental NDF at rates of 0, .16, .33, .49,



or .65% BW/d. Soybean hulls (58.5% NDF) were used to deliver supplemental NDF. Soybean hull supplementation increased ( $P < .01$ ) TNDFD and TADFD compared to no supplementation. Moreover, TNDFD increased quadratically ( $P < .01$ ) and TADFD increased linearly ( $P < .01$ ) with increasing soybean hull supplementation. In trial 3, heifers were fed supplemental ruminally-degradable starch (RDS) at rates of 0, .10, .20, .30, or .40% BW. Dry-rolled corn (72% starch, 75% ruminally degradable) was used to deliver supplemental RDS. Supplemental starch did not affect TNDFD ( $P > .10$ ); however, TADFD by supplemented animals tended to be lower ( $P = .07$ ) than unsupplemented animals. Results were interpreted to suggest that DIP or fiber supplementation positively influenced digestibility of the fiber components of fescue hay-based diets fed to heifers. Conversely, supplemental RDS appeared to have negative effects on ADF digestibility.

**Key Words:** Supplementation, Digestion, Forage

**293 Effect of ruminal infusion of degradable intake protein and starch on utilization of low-quality prairie hay by beef steers.** E. A. Klevesahl\*, R. C. Cochran, E. C. Titgemeyer, T. A. Wickersham, C. G. Farmer, J. I. Arroquy, and D. E. Johnson, *Kansas State University, Manhattan*.

Fourteen Hereford x Angus steers (326 kg initial BW) were used in a 14-treatment, 2-period, crossover design to examine the effects of different ratios of supplemental starch to degradable intake protein (DIP) on low-quality forage utilization and ruminal characteristics. Steers were given ad libitum access to prairie hay (4.9% CP, 42.4% DIP) and supplemented in a 2 x 7 factorial arrangement of treatments. Ruminally administered supplements contained one of two levels of ruminally degradable starch (cornstarch grits; 0 and .3% of initial BW) and one of seven levels of DIP (casein; ranging from 0 to .195% of initial BW). Supplementation with DIP increased forage OM, total OM, NDF, and digestible OM intake in a positive quadratic ( $P < .01$ ) fashion. Starch supplementation depressed ( $P < .01$ ) forage OM and NDF intake by approximately 20%. A supplemental starch x DIP interaction ( $P < .01$ ) was observed for NDF digestion. Supplementation of DIP elicited a positive quadratic response ( $P = .02$ ); however, starch supplementation at low levels of supplemental DIP reduced NDF digestion while at the three highest levels of DIP starch had little effect on NDF digestion. In contrast, DM and OM digestion increased linearly ( $P < .01$ ) with increasing supplemental DIP with no depression from starch supplementation. Total VFA concentrations and ruminal pH were generally inversely related. A decline in ruminal pH was associated ( $P = .02$ ) with increasing supplemental DIP and tended ( $P = .07$ ) to be associated with increasing starch. The observed starch-induced depression in NDF digestion was not dependent upon a depression in ruminal pH. Even though supplemental starch commonly elicits negative effects on forage intake and fiber digestion, the depression in digestion can be overridden with adequate supplemental DIP. This combined with the provision of highly digestible OM in starch supplements can lead to the consumption of relatively similar levels of digestible OM when DIP is not limiting.

**Key Words:** Low-Quality Forage, Starch, Protein

**294 Impact of frequency of supplementation on ruminal fermentation in beef steers consuming low-quality, tallgrass-prairie forage.** C. G. Farmer\*, R. C. Cochran<sup>1</sup>, D. D. Simms<sup>2</sup>, E. A. Klevesahl<sup>1</sup>, and T. A. Wickersham<sup>1</sup>, <sup>1</sup>*Kansas State University, Manhattan*, <sup>2</sup>*Consolidated Nutrition, Omaha, NE*.

The impact of various frequencies of supplementation on ruminal fermentation characteristics was evaluated. Sixteen ruminally fistulated British steers (BW=257 kg) were blocked by BW and assigned to one of four supplementation frequencies. Frequencies of supplementation were 2, 3, 5, and 7 d/wk. Steers were offered tallgrass-prairie hay (73.5% NDF, 4.8% CP) ad libitum. The supplement contained 43% CP and was fed at .36% BW/head daily for steers supplemented 7 d/wk, whereas other treatments received the same amount of supplement per week but equally divided among supplementation events. Ruminal fluid samples were collected at 0, 3, 6, 9, and 12 h post-supplementation on a day when only the 7 d/wk steers were supplemented (D1) and on a day when all steers were supplemented (D2). Treatment x day x time interactions ( $P < 0.01$ ) were observed for all fermentation characteristics. On D1, total VFA was higher for steers supplemented 7 d/wk compared with other steers; whereas on D2, total VFA tended to increase with

decreased frequency of supplementation. The molar proportion of acetate was lower and the molar proportion of propionate was higher on D1 for steers supplemented 7 d/wk compared with other steers. On D2, the molar proportion of acetate decreased and the molar proportion of propionate increased with decreased frequency of supplementation. On D2, ruminal pH decreased as supplementation frequency decreased. Ruminal pH was  $>6.2$  for all observations. On D1, ruminal  $\text{NH}_3$  was higher for steers supplemented 7 d/wk compared with other steers. On D2, ruminal  $\text{NH}_3$  increased with decreased supplementation frequency; moreover steers supplemented 2 d/wk reached peak concentration more slowly and returned to the nadir more slowly. In conclusion, temporal shifts in fermentation patterns were observed with changing frequencies of supplementation as a result of the changes in amount of supplement fed at a particular supplementation event.

**Key Words:** Frequency, Supplementation, VFA

**295 Effect of cooked molasses tubs on performance and health of newly-received stocker cattle.** S. Paisley\*, G. Stokka, and F. Brazle, *Kansas State University*.

Eight paired field comparisons conducted at 3 sites with 1059 newly-received lightweight stocker calves were used to determine the effect of providing low moisture cooked molasses tubs designed for receiving cattle on performance, percentage of cattle treated for respiratory disease, and death loss during a 27- to 32-d receiving period. In each of the eight comparisons, cattle originated from the same source and were randomly assigned during initial processing to two pens with cooked molasses tubs placed in one pen immediately following processing at a rate of no more than 20 calves/tub. All cattle received similar management and nutrition except for the addition of molasses tubs. Tubs offered to calves during the study, provided by Farmland Industries, Inc., were designed to supplement existing receiving rations with additional trace minerals, vitamins and energy with an expected daily intake of .23 kg. Data were analyzed using least squares analysis as a randomized complete block design with pen as the experimental unit. Site, rep within site, tubs (no tubs vs tubs), and site x tubs were included in the model, with site x tubs used as the error term to test for main effects of adding molasses tubs. Site means were separated using Fischer's protected LSD. Cattle without access to stress tubs were slightly heavier ( $P = .17$ ) than steers receiving tubs (196 vs 188 kg). Weight gains were similar ( $P = .36$ ) for cattle with or without access to tubs (19.5 and 17.2 kg, respectively). The addition of tubs also did not affect the number of cattle treated for respiratory disease (36.7 vs 36.7%;  $P = .48$ ). There was a numerical decrease (2.7 vs 1.8%;  $P = .61$ ) in death loss for cattle with access to tubs. Tub consumption (.11 kg/d) was below the desired level of .23 kg/d. Low tub consumption may have compromised any potential for improved performance or overall health response for cattle offered to free choice cooked molasses tubs.

**Key Words:** Cattle, Receiving, Tubs

**296 Effect of low-level fall supplementation with a self-fed, high-protein product and level of winter supplementation on the performance of beef cows grazing tallgrass-prairie range.** T.A. Wickersham\*<sup>1</sup>, R.C. Cochran<sup>1</sup>, D.V. Dhuyvetter<sup>2</sup>, D.M. Grieger<sup>1</sup>, and C.G. Farmer<sup>1</sup>, <sup>1</sup>*Kansas State University, Manhattan*, <sup>2</sup>*Farmland Industry, Kansas City, MO*.

An experiment was conducted to evaluate the effect of delivering small amounts of a self-fed, high-protein supplement during the fall and subsequent level of winter supplementation on beef cow performance. One hundred-sixty spring-calving cows grazing native range were randomly assigned to supplementation treatments in a 2 x 4 factorial arrangement. For the first factor, cows either had access or no access to a self-fed, cooked-molasses supplement (30% CP) during the fall period (10/4/1999 through 11/30/1999). A total of four pastures (two per fall treatment) were used. For the second factor, cattle within each fall treatment were allotted to each of four winter supplementation levels. During the winter period (12/1/1999 through calving) all cows were provided access to the same self-fed supplement used during the fall period plus the daily equivalent of 0.45, 0.91, 1.36, or 1.81 kg range cube/d. Self-fed supplement consumption averaged 0.63 and 0.43 kg/d for the fall and winter periods, respectively. Fall supplementation (FS) elicited no significant changes in body condition score (BCS) or BW during the fall period; however, FS cows tended ( $P = 0.08$ ) to have heavier weights at calving and tended ( $P = 0.08$ ) to exhibit increased losses in BCS from

calving through the beginning of the spring grazing season (5/9/2000). The sole interaction observed ( $P = 0.05$ ) between FS and winter supplementation (WS) was for BCS at calving, where BCS for the FS group was slightly higher across all WS levels except the highest. In general, BCS and BW losses were reduced with increasing level of WS (linear,  $P \leq 0.01$ ) and tended ( $P \leq 0.06$ ) to be inversely related to BW and BCS changes during the early postpartum period. In conclusion, although most performance characteristics were improved in proportion to level of WS, FS exerted only minimal effects on subsequent livestock response.

**Key Words:** Protein, Beef Cattle, Supplementation

**297 Using orchardgrass and endophyte-free fescue versus infected fescue overseeded on bermudagrass for cow herds.** W. K. Coblenz<sup>1</sup>, K. P. Coffey<sup>1</sup>, T. F. Smith<sup>2</sup>, D. A. Scarbrough<sup>1</sup>, J. B. Humphry<sup>1</sup>, D. S. Hubbell, III<sup>2</sup>, J. D. Martin<sup>2</sup>, J. E. Turner<sup>1</sup>, K. F. Harrison<sup>2</sup>, and D. H. Hellwig<sup>1</sup>, <sup>1</sup>University of Arkansas, Fayetteville, <sup>2</sup>Livestock and Forestry Branch Station, Batesville.

Perennial cool-season grasses, such as endophyte-free fescue (FF) and orchardgrass (OG), often have persisted poorly in Arkansas when subjected to the same types of management as infected tall fescue (IF). We have initiated a trial to evaluate the efficacy of overseeding FF or OG into common bermudagrass sods for spring-calving cows. Two management systems have been established in an effort to help these cool-season grasses persist; these include rotations to new paddocks twice weekly or twice monthly. Mixtures of IF and common bermudagrass that were established previously and managed on a twice monthly rotation were included as controls. Sixty-five spring-calving cows (548–68 kg) were stratified by weight, age, and breeding and assigned to one of the 13 4-ha pastures (five cows per pasture) on January 11, 2000. At weaning, cows on IF pastures had lost 39.5 kg, while cows on all other grazing treatments gained at least 30 kg ( $P = 0.029$ ). Over the same time interval, body condition scores for cows grazing IF pastures increased by 0.4 units, which was less ( $P < 0.015$ ) than observed in all other treatments. Grazing treatments also affected actual ( $P = 0.098$ ) and 205-day adjusted ( $P = 0.019$ ) weaning weights; calves weaned from IF pastures weighed less ( $P < 0.10$ ). Pastures were evaluated for species composition in November 1999 and June 2000. Grazing treatment did not affect the percentages of bermudagrass ( $P = 0.78$ ) and cool season grass (IF, FF, or OG) ( $P = 0.79$ ) in the sward; however, percentages of bermudagrass decreased (36.9 vs. 31.6%;  $P = 0.07$ ) and percentages of the desired cool-season grass increased (44.0 vs. 57.1%;  $P = 0.001$ ) between evaluation dates across all pastures. Generally, all cattle performed well with these management techniques, but some decreased performance was observed in cattle grazing IF pastures; overseeding techniques may offer potential to improve cow-calf performance.

**Key Words:** Tall Fescue, Orchardgrass, Grazing

**298 Effect of grazing bermudagrass pastures overseeded with endophyte-free or infected fescue or orchardgrass at two rotation intensities on calf weight change during weaning.** K. P. Coffey<sup>1</sup>, W. K. Coblenz<sup>1</sup>, D. H. Hellwig<sup>1</sup>, T. F. Smith<sup>2</sup>, D. S. Hubbell, III<sup>2</sup>, J. D. Martin<sup>2</sup>, S. L. Krumpelman<sup>1</sup>, K. F. Harrison<sup>2</sup>, D. A. Scarbrough<sup>1</sup>, and J. B. Humphry<sup>1</sup>, <sup>1</sup>University of Arkansas, Fayetteville, <sup>2</sup>Livestock and Forestry Branch Experiment Station, Batesville.

A total of 65 spring-born crossbred calves ( $245 \pm 4.6$  kg) were used in a completely randomized design study to compare the impact of forage type and rotation frequency on weight change and morbidity during the weaning process. Calves grazed with their dams on one of 13 4-ha common bermudagrass pastures overseeded with either infected (IF) or fungus-free fescue (FF), or orchardgrass (OG). Cattle grazing FF and OG were managed using either a two- (LR) or eight-pasture rotation (HR) and those grazing IF were managed using LR. Calves were vaccinated against IBR, BVD, PI<sub>3</sub>, BRSV, five strains of Leptospirosis, seven Clostridial strains, and Haemophilus at four weeks and booster vaccinations were given at two weeks prior to weaning. Calves were removed directly from pasture and dams on October 4, 2000, weighed, transported to a local auction facility, held without feed and water, and weighed beginning at 0130 h to determine sale weight. Calves were then returned to pens with access to water only. Calves were transported

back to the research station at 1100 on October 5, weighed, and monitored for sickness during the next 21 d. Calves previously grazing IF weighed less ( $P < .05$ ) at each weighing than calves previously grazing FF or OG, but shipping shrink and subsequent recovery weight change did not differ ( $P > .10$ ) among forages. Calves grazing LR-managed OG and FF pastures were numerically heavier at weaning ( $P = .12$ ) and upon return from the auction barn ( $P = .10$ ), and were heavier ( $P \leq .05$ ) at subsequent weights thereafter than HR-managed calves. Morbidity did not differ ( $P > .10$ ) due to forage or management. Therefore, forage type and management may alter weaning and purchase weight of calves but does not appear to affect shrink or weight recovery following weaning.

**Key Words:** Weaning, Fescue, Rotational Grazing

**299 Evaluation of winter forage management systems for spring- and fall-calving cows.** N. A. Janovick\* and J. R. Russell, Iowa State University.

Management of spring- and fall-calving cows grazing corn crop residues and stockpiled perennial forages (WG) was compared to feeding hay in a drylot (DL) over two 165-d winter management seasons. Prior to winter grazing, first-cutting forage was harvested as large round bales from duplicate 6.07-ha tall fescue-red clover (TFRC) or smooth bromegrass-red clover (SBRC) pastures. Forage regrowth was grazed for 65 d and, subsequently, fertilized with N at 44.9 kg/ha and stockpiled for winter grazing. For the DL system, first-cutting forage was harvested as large round bales from 4.04 and 6.07 ha in yr 1 and 2, respectively, from duplicate smooth bromegrass-orchardgrass-birdsfoot trefoil pastures. On November 11, 1998 and October 28, 1999, twenty-four spring-calving Angus-cross cows in midgestation were allotted amongst two drylots (DL system) or two 6.07-ha corn crop residue fields (WG system). Simultaneously, 12 Angus-cross cows with calves were allotted amongst two 6.07-ha pastures composed of stockpiled TFRC in the WG system. Spring-calving cows in the WG system grazed corn crop residues for 84 d in yr 1 and 56 d in yr 2 before being moved to SBRC pastures to graze for the remainder of the winter. Organic matter yields (kg/ha) and IVOMD concentrations (% of OM) of corn crop residue, stockpiled TFRC and stockpiled SBRC forages at the initiation of grazing were 3523, 42.2; 2688, 46.4; and 2412, 51.7 in 1998 and 3239, 51.4; 2882, 58.0; and 2116, 52.2 in 1999. Body condition score decreased more ( $P < .05$ ) for fall-calving cows than for spring-calving cows from the initiation of winter grazing until weaning on March 3 of both years. However, there were no differences in body condition score changes between fall-calving cows in the WG system and spring-calving cows in the WG or DL systems over the total winter management period. Amounts of hay required and hay balance per cow for spring-calving cows in the DL system and spring- and fall-calving cows in the WG system were 2151, -822; 624, 3071; and 419, 3714 kg in yr 1 and 2142, 1128; 0, 2164; and 0, 1681 kg DM in yr 2.

**Key Words:** Beef Cattle, Winter, Grazing

**300 Effects of grazing crop residues from Bt-corn hybrids on pregnant beef cows.** J. R. Russell\*<sup>1</sup>, M. J. Hersom<sup>2</sup>, M. M. Haan<sup>1</sup>, M. L. Kruse<sup>1</sup>, and D. G. Morrical<sup>1</sup>, <sup>1</sup>Iowa State University, <sup>2</sup>Oklahoma State University.

To determine the effects of grazing crop residues from Bt-corn hybrids on performance of pregnant beef cows, one non Bt-corn hybrid (Pioneer 3489) and three Bt-corn hybrids (Pioneer 34R07 and Novartis NX6236 with the Yieldgard event and Novartis N64Z4 with the Knockout event) were planted in duplicate 2.8-ha fields in 1998 and 1999. Thirty Angus x Charolais x Simmental cows in midgestation were allotted amongst two drylots or the eight crop residue fields to strip-graze for 126 d. Cow body condition scores were visually estimated biweekly and alfalfa-grass hay was supplemented to maintain a mean body condition score of 5 on a 9-point scale. Crop residue yields and compositions were determined monthly in one 4-m<sup>2</sup> location in each grazed and ungrazed paddock. On two consecutive days after 2 wk of grazing, forage selected during 2 hr of feeding by one fistulated steer per field or drylot was collected by ruminal evacuation. Simultaneously, DMI was calculated from the digestibility of forage determined with indigestible ADF and the fecal output estimated from the passage kinetics of Cr-mordanted fiber (2% Cr) in two cows per field or drylot. Corn hybrid did not affect mean yields of harvested grain, dropped ears or grain, or crop residue DM or

OM over the two years. At grazing initiation, crop residues from Novartis NX6236 and N64Z4 had higher ( $P < .05$ ) concentrations of IVOMD and lower ( $P < .05$ ) concentrations of ADF and ADL than Pioneer 3489 or Pioneer 34RO7. Rates of change in the concentrations of IVOMD, NDF, ADF, ADL and CP over winter did not differ between corn hybrids. Forage selected by fistulated steers did not differ in IVOMD concentrations between winter feeding systems nor NDF, ADF, ADL or ADIN concentrations between corn hybrids. Intakes of forage digestible OM, NDF and ADF did not differ between winter feeding systems. Mean amounts of hay required to maintain body condition score of cows maintained in a drylot were greater than cows grazing crop residues (1454 vs 375 kg DM/cow), but did not differ between corn hybrids.

**Key Words:** *Zea Mays*, Crop Residues, Grazing

**301 Bt corn that is genetically modified to prevent insect damage is equal to conventional corn in feeding value for beef cattle.** M.S. Kerley\*<sup>1</sup>, E.E.D. Felton<sup>1</sup>, J.W. Lehmkuhler<sup>1</sup>, and R. Shillito<sup>2</sup>, <sup>1</sup>University of Missouri, Columbia, <sup>2</sup>Aventis Crop-Science.

Bt corn was developed by genetic modification to prevent insect damage to the plant, resulting in enhanced grain yield and reduced pesticide application. Previous research has demonstrated the safety of feeding Bt corn to cattle. This experiment was conducted to compare the nutritional value of Bt corn event CBH351 (Aventis) to conventional corn for finishing beef cattle. To make this comparison, growth performance and carcass parameters were measured. The experiment was conducted with beef steers at the terminal phase of the finishing period. Thirty-six crossbred steers were allotted to six pens and fed a 75% corn diet (13% crude protein) for 49 days. Steers were transported to a commercial slaughter facility where carcass data (hot carcass weight, yield grade, and quality grade) were collected. Weight gain and feed intake were measured and gain to feed calculated on a pen basis. Sub-samples of each corn variety were collected on a weekly basis prior to diet mixing and analyzed for crude protein. Diets were fed to cattle once daily using a clean bunk-feeding program. The Bt corn and conventional corn had similar crude protein values ( $7.9 \pm 0.2\%$ , respectively). No differences ( $P \geq .05$ ) in average daily gain, intake, gain to feed, yield grade or quality grade were measured. There were no nutritional differences between Bt corn event CBH351 and conventional corn. In conclusion, the genetic modification (Bt) of corn did not change the nutritional value of the corn for finishing beef cattle.

**Key Words:** Corn, Digestion, Feedlot

**302 Long-chain fatty acid flow in and digestion by beef steers fed dry-rolled or high-moisture typical or high-oil corn diets.** M. R. Bolte\*<sup>1</sup>, E. J. Scholljegerdes<sup>1</sup>, B. W. Hess<sup>1</sup>, J. Gould<sup>1</sup>, D. C. Rule<sup>1</sup>, and F. N. Owens<sup>2</sup>, <sup>1</sup>University of Wyoming, Laramie, Wyoming, <sup>2</sup>DuPont Specialty Grains, Des Moines, Iowa.

Our objective was to determine long-chain fatty acid flow in and digestion of corn-based diets by four Angus-crossbred steers (472 kg) fitted with ruminal and duodenal cannulae. Diets were 78% of DM as grain (typical corn or high-oil corn grain in either the dry rolled or high moisture form), 7.5% alfalfa silage, 7.5% alfalfa hay, and 7% supplement. Dry-rolled grains analyzed 52.0 and 89.0 whereas ensiled grains analyzed 44.3 and 83.3 mg total long-chain fatty acids per g organic matter. With the exception of 18:3 ( $P = 0.13$ ), intake of each individual fatty acid was greater ( $P < 0.01$ ) for steers fed high-oil corn. Compared to those fed typical corn, steers fed high-oil corn had greater ( $P < 0.01$ ) duodenal flow of 18:0, 18:1<sup>cis9</sup>, 18:2<sup>cis9cis12</sup>, and 18:3 fatty acids. Ruminal biohydrogenation of 18:1<sup>cis9</sup> and total 18-carbon fatty acids was greater ( $P \leq 0.09$ ) for steers fed high-oil corn than steers fed typical corn grain. But because of greater fatty acid intake, duodenal flow of biohydrogenation intermediates remained greater ( $P = 0.03$ ) for steers fed high-oil corn (12.1 vs 9.3% of duodenal 18-carbon fatty acids). Steers fed high-oil corn had greater ( $P = 0.03$ ) flow of 18:1<sup>trans11</sup>. Steers fed dry-rolled high-oil corn had the greatest duodenal flow of 18:2<sup>cis9trans11</sup>, whereas steers fed high-moisture high-oil corn had greatest flow of 18:2<sup>cis10cis12</sup> (processing method x corn type interactions,  $P < 0.01$ ). Post-ruminal disappearance of 18:0 and total saturated fatty acids was greater (processing x type interactions,  $P \leq 0.08$ ) for steers fed dry-rolled high-oil corn and high-moisture typical corn than steers fed the other diets; however, post-ruminal disappearance of monounsaturated, polyunsaturated, and total unsaturated fatty acids did not differ ( $P \geq 0.27$ ) among diets.

Feeding high-oil corn to cattle is an effective method of increasing the post-ruminal supply of trans-11-vaccenic and conjugated linoleic acids.

**Key Words:** High Oil Corn, Fatty Acids, Digestion

**303 Site and extent of digestion of dry-rolled or high-moisture typical or high-oil corn diets by beef steers.** E. J. Scholljegerdes\*<sup>1</sup>, B. W. Hess<sup>1</sup>, J. Gould<sup>1</sup>, and F. N. Owens<sup>2</sup>, <sup>1</sup>University of Wyoming, Laramie, Wyoming, <sup>2</sup>DuPont Specialty Grains, Des Moines, Iowa.

Our objective was to determine site and extent of digestion of corn-based diets by four Angus-crossbred steers (472 kg) fitted with ruminal and duodenal cannulae. Diets (2.1% of BW daily) contained 78% of DM as grain (typical corn or high-oil corn in either the dry-rolled or high-moisture form), 7.5% alfalfa silage, 7.5% alfalfa hay, and 7% supplement. Dry-rolled grains, typical and high-oil, analyzed (OM basis) 8.8, 9.8, 70.4; 10.0, 13.0, 67.3% whereas ensiled grains analyzed 8.8, 9.1, 71.0; 9.4, 10.4, 67.0% CP, NDF, and starch, respectively. Because of differences in grain composition, steers fed high-oil corn had greater ( $P = 0.07$ ) N intake while steers fed dry-rolled high-oil corn consumed the most ( $P = 0.02$ ) NDF. Ensiling tended to increase ( $P = 0.07$ ) true ruminal OM digestibility for typical corn but not for high-oil corn (processing x type interaction,  $P = 0.11$ ). Ruminal starch digestibility was greatest (processing x type interaction,  $P = 0.06$ ) for steers fed high-moisture typical corn, but post-ruminal starch digestion largely compensated for less ruminal starch digestion and nullified treatment differences ( $P \geq 0.16$ ) in total tract starch digestibility (90 and 92% for dry rolled and 94 and 92% for high moisture grain). Ruminal NDF digestibility was greatest (processing x corn interaction,  $P = 0.04$ ) for steers fed dry-rolled high-oil corn, but post-ruminal and total tract NDF digestibility did not differ ( $P \geq 0.11$ ) among diets. Microbial N flow and efficiency were greater (processing x type interactions,  $P \leq 0.02$ ) for steers fed dry-rolled typical corn and high-moisture high-oil corn than for steers fed other diets. Corn type and processing altered site of digestion, but interactions between type and processing were detected, with ruminal starch availability being increased by ensiling typical (73 vs 54%) but not high-oil corn (61 vs 62%). Thus, ensiling may be less beneficial for increasing starch availability of high-oil than of typical corn grain.

**Key Words:** High Oil Corn, Steers, Digestion

**304 Impact of spontaneous heating during storage of bermudagrass hay on in situ disappearance of DM, fiber, and nitrogen.** L. J. McBeth\*, K. P. Coffey, W. K. Coblenz, J. E. Turner, D. A. Scarbrough, D. H. Hellwig, and D. W. Kellogg, University of Arkansas, Fayetteville.

Spontaneous heating reduced forage quality and subsequent digestibility of nutrients in alfalfa (*Medicago sativa* L.) and cool season grasses. Five crossbred ruminally cannulated steers ( $464 \pm 26$  kg BW) were used in a randomized complete block design study to determine the impact of heating degree-day (HDD;  $> 35^\circ\text{C}$ ) accumulation on in situ degradation kinetics of bermudagrass (*Cynodon dactylon*) hay. Hays had undergone spontaneous heating, producing either 5, 119, 201, 273, or 401 HDD during a 60-d storage period. Either linear or quadratic regressions were used to explain the relationship between HDD and degradation parameters. For DM degradation, linear relationships were detected between HDD and rate of degradation ( $k_d$ ;  $y = 0.040 - 0.00003x$ ;  $P = 0.01$ ;  $R^2 = 0.26$ ) and effective degradability ( $y = 46.9 - 0.016x$ ;  $P < 0.01$ ;  $R^2 = 0.58$ ). For NDF degradation, quadratic relationships were detected between HDD and fraction C ( $y = 32.1 - 0.043x + 0.0001x^2$ ;  $P = 0.02$ ;  $R^2 = 0.30$ ) and  $k_d$  ( $y = 0.052 - 0.0002x + 3.05 * 10^{-7} x^2$ ;  $P = 0.01$ ;  $R^2 = 0.36$ ); a linear relationship was detected between HDD and effective NDF degradability ( $y = 39.0 - 0.012x$ ;  $P = 0.01$ ;  $R^2 = 0.33$ ). For N degradation, linear relationships were detected between HDD and  $k_d$  ( $y = 0.039 - 0.00005x$ ;  $P < 0.01$ ;  $R^2 = 0.62$ ), and effective degradability ( $y = 52.6 - 0.025x$ ;  $P < 0.01$ ;  $R^2 = 0.61$ ). For NDIN disappearance, linear relationships were detected between HDD and fraction C ( $y = 12.3 + 0.021x$ ;  $P < 0.01$ ;  $R^2 = 0.32$ ),  $k_d$  ( $y = 0.054 - 0.00006x$ ;  $P < 0.01$ ;  $R^2 = 0.47$ ), and effective NDIN degradability ( $y = 56.5 - 0.038x$ ;  $P < 0.01$ ;  $R^2 = 0.68$ ). Therefore, spontaneous heating decreases the bioavailability of bermudagrass hay in situ by reducing the rate and effective ruminal degradation of forage DM, NDF, N and NDIN.

**Key Words:** Spontaneous Heating, Degradation Kinetics, In Situ

**305 Application of a fermentation aid (Silo-King®) at increasing rates on the availability of nutrients from alfalfa haylage. 1. Digestibility of dry matter, protein, and fiber.** G. Ayangbile, D. P. Casper\*, J. Meier, and D. Spangler, *Agri-King, Inc., Fulton, IL.*

Silo-King® enhances the fermentation and storage of forages, but data are lacking for its effect on digestibility and absorption of nutrients during feeding. First crop alfalfa was cut on 5/28/2000 and allowed to wilt for 24 hr and ensiled in 208 l silos. Treatments were Silo-King® applied at 4 rates of 0 g (Control; OX), 150 g (1X), 300 g (2X), and 450 g (3X) per 907 kg of alfalfa haylage at the time of ensiling. Haylages fermented for 38 d after which twenty-four (24) sheep were blocked by body weight ( $\mu = 28.5 \pm 3.9$  kg) and randomly assigned to 1 of 4 treatment diets using a replicated (6) 4 x 4 latin square design. Experimental periods were 7 d with the first 3 d for dietary adaptation followed by a 4 d total collection of feces and urine. Diets contained 28.1% (DM basis) ground shelled corn, 30.2% ground corn cobs, .7% mineral mix, and 41.0% of the respective treated haylage. Diets contained similar ( $P > .05$ ) concentrations of CP (14.2, 14.5, 14.4, and 14.3% for OX, 1X, 2X, and 3X, respectively), NDF (38.9, 38.8, 39.4, and 40.9%), and starch (21.9, 21.3, 21.6, and 21.1%). Digestibility of DM was greatest ( $P < .05$ ) for sheep fed the 3X diet (55.9, 57.6, 59.3, and 61.1%) compared to sheep fed the OX diet with sheep fed diets 1X and 2X being intermediate. Digestibility of CP (58.9, 60.7, 62.6, and 62.6%) and N retention (5.2, 6.5, 7.8, 7.7 g/d) were lower for sheep fed the OX diet and greatest for sheep fed diets 2X and 3X with diet 1X being intermediate. Digestibility of NDF (26.5, 30.2, 34.8, and 41.1%) was lowest for sheep fed the OX diet and greatest for sheep fed the 3X diet, with sheep fed diet 1X and 2X being intermediate. Digestibility of starch (92.8, 91.7, 91.0, and 92.0%) was similar ( $P > .05$ ) for sheep fed all diets. The responses in digestibilities due to application rate of Silo-King® were linear for DM ( $r^2 = .65$ ,  $P < .01$ ), CP ( $r^2 = .41$ ,  $P < .01$ ), and NDF ( $r^2 = .80$ ,  $P < .01$ ). The application of Silo-King® at ensiling can improve digestibility and absorption of nutrients from forages.

**Key Words:** Fermentation Aid, Digestibility, Alfalfa Haylage

**306 Application of a fermentation aid (Silo-King®) at increasing rates on the availability of nutrients from alfalfa haylage. 2. Digestibility of minerals.** D. P. Casper\*, G. Ayangbile, J. Meier, and D. Spangler, *Agri-King, Inc., Fulton, IL.*

Silo-King® enhances the fermentation and storage of forages, but data are lacking for its effect on digestibility and absorption of minerals during feeding. First crop alfalfa was cut on 5/28/2000 and allowed to wilt for 24 hr and ensiled in 208 l silos. Treatments were Silo-King® applied at 4 rates of 0 g (Control; OX), 150 g (1X), 300 g (2X), and 450 g (3X) per 907 kg of alfalfa haylage at the time of ensiling. Haylages fermented for 38 d after which twenty-four (24) sheep were blocked by body weight ( $\mu = 28.5 \pm 3.9$  kg) and randomly assigned to 1 of 4 treatment diets using a replicated (6) 4 x 4 latin square design. Experimental periods were 7 d with the first 3 d for dietary adaptation followed by a 4 d total collection of feces and urine. Diets contained 28.1% (DM basis) ground shelled corn, 30.2% ground corn cobs, .7% mineral mix, and 41.0% of the respective treated haylage. Diets were similar ( $P > .05$ ) in concentrations of Ca (.71, .70, .69, and .72% of DM for OX, 1X, 2X, and 3X, respectively), P (.28, .29, .28, and .29%), Mg (.25, .26, .26, and .27%), and S (.19, .19, .19, and .19%). Apparent Ca digestibility was lowest ( $P < .05$ ) for sheep fed the OX diet and greatest for sheep fed the 3X diet (29.2, 30.0, 33.7, and 36.9%) with sheep fed diets 1X and 2X being intermediate. Apparent digestibility of P (21.7, 26.8, 28.4, and 33.9%) and Mg (28.1, 32.7, 34.3, and 35.3%) were greater ( $P < .05$ ) for sheep fed the Silo-King treated haylage (1X, 2X, and 3X) compared to sheep fed diet OX. Apparent digestibility of S was greatest ( $P < .05$ ) for sheep fed the 3X diet compared to sheep fed the OX diet (38.4, 41.0, 41.8, and 45.3%) while sheep fed the diets 1X and 2X diets were similar, but different from diets OX and 3X. The responses in digestibilities due to application rate of Silo-King® were linear for Ca ( $r^2 = .34$ ,  $P < .01$ ), P ( $r^2 = .38$ ,  $P < .01$ ), Mg ( $r^2 = .27$ ,  $P < .01$ ), and S ( $r^2 = .57$ ,  $P < .01$ ). The application of Silo-King® at ensiling can improve digestibility and absorption of minerals from forages.

**Key Words:** Fermentation Aid, Minerals, Digestibility

**307 Application of a fermentation aid (Silo-King®) at increasing rates on the availability of nutrients from alfalfa haylage. 3. Ruminal fermentation and solubility parameters.** J. Meier, G. Ayangbile, D. P. Casper\*, and D. Spangler, *Agri-King, Inc., Fulton, IL.*

Silo-King® enhances the fermentation and storage of forages, but data are lacking for its effect on ruminal digestion and fermentation. First crop alfalfa was cut on 5/28/2000 and allowed to wilt for 24 hr and ensiled in 208 l silos. Treatments were Silo-King® applied at 4 rates of 0 g (Control; OX), 150 g (1X), 300 g (2X), and 450 g (3X) per 907 kg of alfalfa haylage at the time of ensiling. Haylages fermented for 38 d after which twenty-four (24) sheep were blocked by body weight ( $\mu = 28.5 \pm 3.9$  kg) and randomly assigned to 1 of 4 treatment diets using a replicated (6) 4 x 4 latin square design. Experimental periods were 7 d with rumen fluid collected on the last day of each experimental period. Diets contained 28.1% (DM basis) ground shelled corn, 30.2% ground corn cobs, .7% mineral mix, and 41.0% of the respective treated haylage. Total volatile fatty acid concentrations (104.3, 106.3, 104.5, and 106.2  $\mu\text{mole/ml}$  for OX, 1X, 2X, and 3X, respectively) were similar ( $P > .05$ ) for sheep fed all diets. Molar concentrations of acetate (67.7, 67.6, 68.0, and 69.1%) and propionate (18.2, 18.3, 18.3, and 17.5%) were greatest ( $P < .01$ ) and lowest ( $P < .06$ ), respectively for sheep fed the 3X diet compared to sheep fed diets OX, 1X, and 2X. Acetate to propionate ratios (3.75, 3.73, 3.79, and 4.01) were greatest ( $P < .04$ ) for sheep fed the 3X diet compared to sheep fed diets OX, 1X, and 2X. Ruminal ammonia concentrations (84.8, 78.6, 74.0, and 77.8 mmol) tended ( $P < .08$ ) to be reduced for sheep fed the 2X diet compared to sheep fed the OX diet with sheep fed diets 1X and 3X being intermediate. Soluble phosphorus concentrations (318.0, 346.5, 325.0, and 351.6 mg/l) in rumen fluid were greater ( $P < .04$ ) for sheep fed the 3X diet compared to sheep fed diet OX with sheep fed diets 1X and 2X being intermediate. The application of Silo-King® at ensiling can influence ruminal fermentation and mineral solubility from forages.

**Key Words:** Fermentation Aid, Ruminal Fermentation, Alfalfa Haylage

**308 Synchronization of nonstructural carbohydrate and protein degradability on ruminal fermentation in rumen-simulating fermenters.** D. P. Casper\*<sup>1</sup>, D. J. Schingoethe<sup>2</sup>, and G. A. Harrison<sup>2</sup>, <sup>1</sup>*Agri-King, Inc., Fulton, IL,* <sup>2</sup>*South Dakota State University.*

Previous research on the synchronization of nonstructural carbohydrate (NSC) and crude protein (CP) degradability with barley based diets has not consistently improved animal performance. Synchronization of NSC and CP was evaluated using a single flow continuous culture fermenter system. Six fermenters arranged in a randomized complete block design having a 3 x 2 factorial arrangement of treatments were used to evaluate 3 sources of NSC (corn, C; midwest barley, MB; and west coast barley, WB) with 2 sources of CP degradability (soybean meal, S; and extruded soybean meal, E) on pH, volatile fatty acids (VFA), and ammonia concentrations. Diets consisted of 25% alfalfa hay (DM basis), 25% corn silage, and 50% of the respective concentrate mix and were fed at the rate of 10 g (DM basis) 2 x/d daily. Experimental periods were 7 d with the last 4 days for data collection. No interaction ( $P > 0.15$ ) of NSC by CP sources were detected for any variables except ammonia. Concentrations of ammonia were greatest ( $P < 0.01$ ) for fermenters fed the C-S diet (5.99, 4.23, 4.24, 4.44, 4.68, and 4.58 mg/dl for C-S, C-E, MB-S, MB-E, WB-S, WB-E, respectively; interaction of NSC by CP,  $P < 0.02$ ) compared to fermenters fed all other diets. Ruminal pH (6.49, 6.55, and 6.54 for C, MB, and WB, respectively) was decreased ( $P < 0.02$ ) for fermenters fed C compared to fermenters fed MB and WB diets, while CP source did not affect pH (6.52 and 6.53 for S and E, respectively). Concentrations of VFA (67.2, 63.6, and 66.2  $\mu\text{mole/ml}$ ) were lower ( $P < 0.08$ ) for fermenters fed MB compared to fermenters fed C and WB diets, while CP source did not affect VFA (65.5 and 65.8  $\mu\text{mole/ml}$ ). The decrease in VFA concentrations was due to less butyrate (9.56, 8.57, and 8.93  $\mu\text{mole/ml}$ ) for fermenters fed MB diets. These data indicate that previous results observed when feeding lactating cows barley based diets in the midwest may be due to a reduction in VFA production. Degradability of CP (S versus E) had no effect on ruminal fermentation parameters.

**Key Words:** Nonstructural Carbohydrate Degradability, Protein Degradability, Synchronization

**309 Potential degradation of leafy spurge toxins in cattle rumen digesta.** M.B. Hubert\*<sup>1</sup>, S.L. Kronberg<sup>2</sup>, and F.T. Halaweish<sup>1</sup>, <sup>1</sup> *South Dakota State University*, <sup>2</sup> *USDA ARS*.

Leafy spurge invasion of pastures in the northern Great Plains is a serious problem mainly because cattle can't tolerate toxins in spurge and therefore learn to avoid it. Differential degradation of leafy spurge toxins in the rumen may help explain differences in tolerance for this weed by cattle, sheep and goats. We evaluated toxicity of leafy spurge after *in vitro* fermentation with normal or modified cattle ruminal digesta. Digesta was obtained from ruminally-cannulated cattle on an alfalfa/grass hay diet. Seventy-five ml of whole digesta was mixed with 300 ml of buffer solution and 26 g of ground (1 mm screen) leafy spurge or alfalfa (control), gassed with carbon dioxide and incubated at 39°C. For one treatment, .5 mg of neomycin sulfate antibiotic was added to the mixture in order to alter the population of microbes. Fermentations were stopped at 15 min, 6 h and 12 h by freezing the mixtures quickly in zip-loc bags. Fermentations were extracted with petroleum ether, and ether was evaporated from extracts before they were tested for toxicity using a brine shrimp assay (10 live shrimp/replicate were exposed to each extract for 24 h at 50 µg extract/ml of solution). Shrimp assays with extracts from the 15-min fermentations resulted in 9.8, 6.5 and 6.8 live shrimp for the alfalfa, leafy spurge and leafy spurge/antibiotic treatments, respectively. The two leafy spurge treatments had similar toxicity to the shrimp (P=.52), and both were more toxic than the alfalfa control (P<.0001). Adding an antibiotic to the mixture did not increase or decrease the toxicity of the extracts to the shrimp (P=.33); however, length of fermentation had a strong effect on toxicity with greater time of fermentation resulting in less toxicity of extracts from the two spurge treatments (P<.0001). These results indicate that ruminal microbes in cattle may be able to degrade the toxins in leafy spurge at only a slow rate, and that neomycin sulfate does not alter rumen microbial populations such that toxin degradation is altered.

**Key Words:** Leafy Spurge, Toxicity, Rumen Degradation

**310 Effects of monensin on eating behavior when administered continuously into the rumen or portal vein.** S. Bierman\* and R.H. Pritchard, *South Dakota State University*.

Five steers (BW = 374 ± 22.9 kg) were used to evaluate effects on eating behavior when monensin-Na (MON) was continuously dosed (144 h) into either: C) ethanol carrier dosed into the rumen at rate of 8 ml/h (n=5); R) rumen at 10.4 mg/h (n=4); P1) portal vein at 5.2 mg/h (n=3); or P2) 10.4 mg/h (n=4). A CRD trial was conducted with 14 d periods consisting of a 4 d pre-dose phase where steers remained in pens. Steers were moved to stanchions for dose phase (d 2 to 7) and post-dose phase (d 8 to 10). There was a minimum of 11 d between periods. An 85% concentrate diet (2.0 Mcal NEm/kg and 1.3 Mcal NEg/kg) was fed daily at 0900. Individual bunk weights were recorded daily every .5 h post-feeding for 12 h. Data were analyzed by two-way classifications, daily (steer and day) with steer as replicate, and hourly (steer and treatment) with day as replicate. Treatment means were separated by least significant difference. Two of 4 steers that received P2 and 1 of 3 steers that received P1 had complete inhibition of DMI within 24 h and dosing terminated within 86 h post-start of dosing. Reported data include clinical steers. Day was not different for R and P2, indicating no adaptation to effects of MON. P1 had suppressed DMI on d 3 to 5 compared to d 2, 6 and 7 (P<.01) and tended to have treatment x day interaction with C (P=.11). Monensin slowed daily rate of DMI (3.4 vs 2.4, 2.7 and 2.1 g/kg MBS h<sup>-1</sup>; C, R, P1 and P2, respectively; P<.02). Monensin caused accumulated DMI h<sup>-1</sup> to be similar among steers but C did not (P<.01). Monensin caused greater change (P<.01) between dose and pre-dose DMI than C (-14.7 vs -38.9, -40.2 and -45.4 g/kg MBS; C, R, P1 and P2, respectively). Rumen exposure to MON suppressed DMI at 4.5 to 24 h (P<.09) and P1 exposure suppressed DMI at 10.5 to 24 h (P<.02) and P2 tended to at .5 to 4 h (P=.14) and at 4.5 to 24 h (P<.09) post-feeding. Higher levels of MON appear necessary to continue elicitation of satiety at the portal vein. Monensin elicited satiety quicker for P2 than R. Both rumen and portal vein exposure to MON altered eating behavior.

**Key Words:** Monensin, Beef, Satiety

**311 Benefits of sorting calves as feeders on feedlot performance and carcass value.** A. Trenkle\*, *Iowa State University*.

Eighty pens (six per pen) of Angus steer calves with an average starting weight of 23118.4 kg were sorted into two groups based on calculated frame score using the BIF equation (4.1 & 5.0 for smaller frame, SF & larger frame, LF, P<.01) and each of these groups further divided into two groups based on backfat thickness measured with ultrasound (0.16 & 0.26 cm for less back fat, LBF & more back fat, MBF, P<.01). Calves were purchased two years from one ranch and one group one year from another ranch. Calves were sorted within each of the three groups and the results combined for analysis. All the steers were fed the same finishing diet (88% corn and supplement & 12% corn silage) and received the same implants (Component E-S<sup>®</sup> initial & ET-S<sup>®</sup> terminal). LF steers had larger initial REA (39.2 & 43.1 cm<sup>2</sup>, P<.05). Calves had similar ages in each of the sorted groups (mean = 239 d). There were no significant frame x BF interactions for any of the measurements. Means for days fed; ADG (kg); feed DM/d (kg) and gain/feed for SF, LF, LBF & MBF were 190.4, 191.3, 193.5 & 188.2 (P<.05); 1.60, 1.65 (P<.05), 1.64 & 1.61 (P<.1); 8.5, 9.0 (P<.01), 8.7 & 8.8 and 0.190, 0.185, .0190 & 0.185, respectively. Carcass weight (kg); backfat (cm); REA (cm<sup>2</sup>); calculated yield grade; marbling score (400 = small<sup>0</sup>); carcass value (\$/carcass based on a grid with premiums for high marbling, YG 1 & 2 and Certified Angus Beef and discounts for low marbling, YG 4 and carcass weights) and return per head (\$2.09/kg purchase cost, \$.1237/kg feed DM & \$.40/d nonfeed) were 327, 352 (P<.01), 341 & 337; 1.16, 1.10, 1.03, & 1.23 (P<.01); 79.9, 83.4 (P<.01), 81.7 & 81.6; 3.12, 3.14, 3.08 & 3.17; 435, 425, 425 & 436; 835, 895 (P.01); 872 & 858 and 105.18, 89.59, 111.44 & 83.38 for the respective sorted groups. LF steers had superior performance and greater carcass value but economic returns were \$15.59 less than SF because of greater purchase and feed costs. The differences in performance and carcass measurements due to the initial sort on backfat tended to not be significant but economic returns were \$28.06 greater for LBF steers because of less purchase cost and more premiums for YG 1 and 2 carcasses.

**Key Words:** Cattle, Carcass Value, Sorting

**312 Effect of age at feedlot entry on performance and carcass characteristics of bulls and steers.** J. P. Schoonmaker\*, F. L. Fluharty, S. C. Loerch, and T. B. Turner, *The Ohio State University*.

Seventy Angus x Simmental crossbred calves (initial BW 166.2 ± 4.2 kg) were used in a 3 x 2 factorial arrangement of treatments to determine the effect of age at feedlot entry and castration on growth, performance, and carcass characteristics. At 82 d of age (5-26-99), calves in the steer group were castrated. Calves were placed in the feedlot at 110 d of age (EW), 202 d of age (NW), or 371 d of age (Y). Calves in the NW and Y group remained with their dams until 188 d of age, and consumed pasture until feedlot entry (202 and 371 d of age; respectively). Steers were implanted with Synovex-S<sup>®</sup> (when steers were approximately 93 d from their terminal implant), and with Revalor-S<sup>®</sup> (when steers were estimated to be 100 d from slaughter). Calves were slaughtered on an individual basis when backfat was estimated to be 1.3 cm. While in the feedlot, Y calves gained faster (P<.01) than NW and EW calves (1.88, 1.68, 1.62 kg/d); however, when measured from 110 d of age until slaughter, ADG was greatest for EW, intermediate for NW, and lowest for Y calves (1.62, 1.47, 1.21 kg/d; P<.01). Early-weaned calves spent the most d in the feedlot, followed by NW, and Y calves spent the fewest d in the feedlot (221, 190, 163 d; P<.01). Total DMI was similar (P>.02) was similar for age groups; however, daily DMI was the lowest for EW, intermediate for NW, and the highest for Y calves (7.1, 8.1, 10.5 kg/d; P<.01). Early-weaned calves were the most efficient, followed by NW, and Y calves were the least efficient (227, 207, 180 g gain/kg feed; P<.01). Weight at slaughter (682, 582, 517 kg; P<.01) and hot carcass weight (413, 358, 314 kg; P<.01) was greatest for Y calves, intermediate for NW, and lowest for EW. Early-weaned calves had the smallest rib-eye area, followed by NW, and Y had the largest rib-eye area (76, 86, 88 cm<sup>2</sup>; P<.01). Early-weaned and NW calves had lower yield grades (3.2, 3.1, 3.5; P<.04), and produced fewer select carcasses compared to Y calves (25, 13, 48 %; P<.01). Bulls and steers both had an average daily gain of 1.7 kg/d while in the feedlot; however, bulls had a greater (P<.09) hot carcass weight (370 vs 354 kg) and a larger (P<.01) rib-eye area (86 vs 81 cm<sup>2</sup>) compared to steers. Earlier feedlot placement results in higher quality beef.

**Key Words:** Feedlot Age, Bulls, Steers

**313 Effect of rate of liveweight gain during winter on subsequent feedlot performance of cattle.** M. J. Hersom\*, G. W. Horn, and C. R. Krehbiel, *Oklahoma State University*.

Forty-eight fall-weaned Angus x Angus/Hereford steer calves (244±23 kg) were used in a completely random design to determine the effect of rate of liveweight gain during the winter on growth and feed efficiency, carcass merit and empty body composition in the finishing phase. During the 120-d growing phase, the three treatments were high (HGW, 1.28 kg/d) and low (LGW, 0.48 kg/d) gain on wheat pasture and winter grazing of dormant tallgrass native range (NR, 0.21 kg/d). Stocking density was used to produce the desired rates of gain on wheat pasture. Steers grazing NR were offered 0.91 kg/d of cottonseed meal based 41 % CP supplement. Prior to the feedlot phase, four steers from each treatment were harvested to measure initial empty body composition. The remaining 36 steers were placed into three pens/treatment and fed a whole-shelled corn finishing diet. Steers were harvested at a common endpoint of 1.27 cm of 12th rib backfat as determined by ultrasound. Final empty body composition and carcass traits were measured after a 48-h chill. During all periods, DMI (% initial BW) of HGW steers was lower ( $P < 0.05$ ) than LGW and NR steers. There were no differences in ADG or feed efficiency among the three treatments. Carcass weights were greater ( $P < 0.05$ ) for HGW than LGW steers; however yield grade, ribeye area, and marbling score was similar among the treatments. These data indicate that LGW and NR steers did not exhibit compensatory growth compared to HGW steers. Despite heavier initial BW of HGW steers, ADG and feed efficiency conversion was similar to LGW and NR steers.

	HGW	LGW	NR	SEM
Initial BW, kg	404 <sup>a</sup>	311 <sup>b</sup>	256 <sup>c</sup>	2.4
Final BW, kg	587 <sup>a</sup>	546 <sup>b</sup>	570 <sup>ab</sup>	8.0
Days fed	91 <sup>a</sup>	123 <sup>b</sup>	165 <sup>c</sup>	0.0
Feed DMI, % BW				
Days 0-29 <sup>d</sup>	1.86 <sup>a</sup>	2.17 <sup>b</sup>	2.29 <sup>b</sup>	0.03
Days 30-50 <sup>d</sup>	2.26 <sup>a</sup>	2.60 <sup>b</sup>	2.73 <sup>c</sup>	0.04
Days 0-harvest <sup>e</sup>	2.15 <sup>a</sup>	2.47 <sup>b</sup>	2.51 <sup>b</sup>	0.04
ADG, kg/d				
Days 0-29	2.09	2.37	2.23	0.17
Days 30-50	2.28	2.49	2.25	0.17
Days 0-harvest	2.01	1.91	1.90	0.06
Gain:Feed DM, kg	0.193	0.187	0.190	0.004

<sup>abc</sup>Within a row, means without a common superscript letter differ ( $P < 0.05$ ). <sup>d</sup>Initial BW <sup>e</sup>Mean BW

**Key Words:** Growing Cattle, Winter Weight Gains, Feedlot Performance

**314 Effect of altered feeding regimen on performance and body temperature of steers finished in the summer.** M. S. Davis\*<sup>1</sup>, T. L. Mader<sup>1</sup>, S. M. Holt<sup>2</sup>, and W. M. Cerkoney<sup>1</sup>, <sup>1</sup>University of Nebraska, Concord, <sup>2</sup>University of Queensland-Gatton, Gatton, Australia.

Angus, Angus x Charolais steers (144) were randomly assigned to one of 24 pens (6 hd/pen). Treatments (TRT) assigned to pens consisted of; 1) ad libitum feeding at 0800 h (ADLIB), 2) ad libitum feeding at 1600 h with bunks slick by 0800 h (BKMGT), and 3) limit-fed at 85% ad libitum at 1600 h (LIMFD). Treatments were imposed through day 22 during the early through mid-portions of July (managed feeding period; [MF]), at which time all steers were offered ad libitum feed at 0800 h (ad libitum period; [AL]). Steers were weighed upon initiation of trial, day 23, and termination (day 82). Daily feed and water intakes were recorded. Tympanic temperatures were obtained on 24 steers under thermoneutral (TNL) and hot environmental conditions during MF, and hot conditions during AL. Panting and bunk scores were recorded during TNL and hot conditions. Steers were slaughtered on day 83, hot carcass weight, back fat thickness, yield grade and marbling score were obtained. Overall DMI, ADG, feed efficiency, and carcass characteristics were not affected by TRT ( $P \geq .10$ ). Water intake tended to be reduced ( $P \leq .10$ ) for LIMFD steers during both MF and AL periods. Tympanic temperatures were decreased ( $P \leq .05$ ) during MF for BKMGT and LIMFD steers and continued to be lower ( $P \leq .05$ ) for LIMFD during AL. Panting scores were not affected by TRT during TNL conditions, however under hot conditions LIMFD steers tended to have lower ( $P \leq .10$ ) scores at 1700 h. Eating pattern, as observed by bunk scores, was not altered ( $P \geq .10$ ) by environmental conditions in BKMGT steers. Managed feeding programs were imposed without

negatively affecting performance. In addition, altering feeding regimen during periods of potentially high environmental heat load lowers body temperature, thus decreasing the probability of heat-related death loss.

**Key Words:** Managed Feeding, Heat Stress, Temperature

**315 Effect of conventional vs. restricted adaptation to a high-concentrate diet on performance and carcass characteristics of feedlot calves.** W. T. Choat\*, C. R. Krehbiel, D. R. Gill, T. C. Stovall, J. A. Shriver, and R. L. Ball, <sup>1</sup>Oklahoma State University.

Limit feeding the final diet compared with adaptation using decreasing roughage has been shown to improve feed efficiency and decrease the amount of roughage required during initial adaptation in yearling cattle. However, little information is available concerning this method of adaptation in calves. The objective of this study was to evaluate the effects of limit feeding the final diet vs ad libitum feeding of four step-up diets on performance and carcass traits of calves. Steer calves (n=150; BW=289±1.2 kg) were blocked by weight and randomly allotted to 30 pens (10 pens/block; 5 hd/pen). Five pens/block were assigned to one of two treatments: 1) ad libitum feeding of four step-up diets over a 20-d period with levels of dry-rolled corn increasing from 52 to 80 percent (DM basis), or 2) limit feeding the final diet with predetermined increases in intake until ad libitum intake was achieved. Initial intake of limit-fed steers was calculated (NRC, 1996) to meet energy intakes equivalent to that of ad libitum steers consuming 2% of BW (DM basis). Steers were fed once daily. Overall daily gain was greater ( $P < .05$ ) for ad libitum steers compared with limit-fed steers (1.63 vs 1.49±.02). Daily intake was lower ( $P < .05$ ) for limit-fed steers (8.9 vs 9.5±.08 kg) and the resulting gain:feed tended ( $P = .11$ ) to be improved for steers limit-fed during adaptation. Improvement in feed efficiency was attributed to lower DMI ( $P < .05$ ) and greater ( $P < .05$ ) daily gains from d 14 to 56 of the experiment. Final BW and HCW were decreased ( $P < .05$ ) when steers were limit-fed. No differences were observed among treatments for %KPH, 12th rib fat, USDA quality and yield grade, and liver scores. Use of limit feeding as a method of adaptation reduced daily gain and carcass weight; therefore, limit feeding the final diet might be more efficacious in yearlings compared with calves.

**Key Words:** High-Grain Diets, Cattle, Adaptation

**316 Influence of restricted intake and reduced dietary starch on colon pH and *E. coli* prevalence.** J.D. Folmer\*, C.B. Wilson, D.L. Bailey, M.P. Blackford, T.W. Loy, S.M. Younts, R.A. Moxley, D.R. Smith, and T.J. Klopfenstein, *University of Nebraska, Lincoln*.

Ninety feedlot steers (545 kg) and 18 pens (5 hd/pen; and 2 pens/trt) were used to test the effects of reducing dietary starch and intake on colon (COL) pH, VFA, total and acid-resistant coliform, *E. coli* populations, and *E. coli* O157:H7 shedding. Using a 3 x 3 factorial design, three diets at three levels of intake delivered varying amounts of unfermented starch to the colon. The low (L) diet contained corn bran and wet corn gluten feed (WCGF), the medium (MED) diet contained WCGF and high moisture corn, and the high (H) diet contained dry rolled corn. Diets were offered ad libitum (AL), 65% of ad libitum (65%), and 45% of ad libitum (45%), and were fed for a 14d diet adaptation and intake determination period, prior to 10d fecal sampling. Total coliform and acid-resistant coliform, VFA's, and *E. coli* were quantified and presence of *E. coli* O157:H7 was determined. Cattle consuming L and MED diets had significantly higher ( $P < .01$ ) COL pH values, than the H diet, 7.52, 7.25, and 6.90 respectively. In addition, the L diet reduced the amount of VFA in the COL ( $P < .05$ ) compared with the H diet. As level of intake decreased, COL pH increased ( $P < .01$ ), with AL intake averaging a COL pH of 7.29 while pH increased to 7.35 and 7.46 for 65% and 45% intake, respectively. The amount of COL VFA decreased ( $P < .01$ ) with intake restriction, from 150 to 131 and 110 mMol for AL, 65%, and 45% intake, respectively. The total number of coliform on d 1 did not differ ( $P > .05$ ) among diets. Acid-resistant coliforms ( $P < .01$ ), and acid-resistant *E. coli* ( $P < .05$ ), were reduced by the L and MED diets. Total number of *E. coli* was lower ( $P < .01$ ) for the MED diet compared with the other diets, and the L diet tended to be lower than the H diet ( $P < .06$ ). The daily number of cattle shedding *E. coli* O157:H7 ranged from 0 to 18%. Although, daily prevalence of *E. coli* O157:H7 was not affected by diet ( $P = .86$ ) or intake ( $P = .58$ ). Diets low in starch increase

fecal pH, lower VFA, and reduce numbers of acid resistant *E. coli* in the feces.

**Key Words:** Cattle, *E. coli*, Starch Intake

### 317 Comparison of Synovex® Plus™, Revalor® -H, and Finaplix® -H in feedlot heifers fed MGA®. C.N. Macken\*<sup>1</sup>, C.T. Milton<sup>1</sup>, B.D. Dicke<sup>2</sup>, and F.L. Prouty<sup>3</sup>, <sup>1</sup>University of Nebraska, Lincoln, <sup>2</sup>Cattlemen's Consulting, Lincoln, <sup>3</sup>Fort Dodge Animal Health, Overland Park, KS.

One thousand five hundred fifty-eight heifers (345 kg) were randomly allotted to one of three treatments (18 pens; 6 reps/trt) in a commercial feedlot. Heifers were implanted with Ralgro® d 0, and reimplanted with Synovex Plus (SynPlus), Finaplix-H (FinH) or Revalor-H (RevH) 95 d prior to slaughter. MGA was fed to all treatments. Heifers were fed a steam-flaked corn-based diet for 139 d. Dry matter intake was higher (9.2, 9.1 vs. 8.8 kg/d;  $P < 0.05$ ) for heifers implanted with SynPlus or RevH versus FinH, respectively. On a carcass-adjusted basis (63% common dressing percentage), heifers implanted with SynPlus gained 4.1% (1.60 kg/d;  $P < 0.10$ ) faster than heifers implanted with RevH (1.54 kg/d) or FinH (1.53 kg/d). Daily gain was similar for heifers implanted with RevH or FinH. Feed efficiency was similar among treatments. Hot carcass weight was 4.54 kg ( $P < 0.05$ ) heavier for heifers implanted with SynPlus (357 kg) compared to heifers implanted with RevH (354 kg) or FinH (352 kg). Hot carcass weight was similar between RevH and FinH. Dressing percentage and longissimus muscle area were greater ( $P < 0.05$ ) for heifers implanted with SynPlus compared to FinH, with RevH being intermediate. Calculated yield grade and 12th rib fat was similar among treatments. Marbling score and percentage of heifers grading USDA Choice or higher were lower ( $P < 0.10$ ) for heifers implanted with SynPlus (Sm26; 55.1%) compared to RevH (Sm37; 65.5%) or FinH (Sm47; 67.4%). Percentage of heifers grading U.S.D.A. Select was higher ( $P < 0.10$ ) for those implanted with SynPlus (41.7%) compared to RevH (33.1%) or FinH (31.2%). Heifers grading Standard were similar among treatments (2.0%). Implanting heifers with SynPlus improves daily gain, however, there appears to be some reduction in carcass quality compared to RevH and FinH.

**Key Words:** Finishing, Heifers, Implants

### 318 Effect of implanting on performance and carcass characteristics of finishing steers. W. T. Choat\*, C. R. Krehbiel, D. R. Gill, T. C. Stovall, J. A. Shriver, and R. L. Ball, Oklahoma State University.

The objective was to determine the effect of implant strategy on finishing performance and carcass characteristics. Crossbred steers ( $n = 150$ ; BW =  $289 \pm 1.9$  kg) were blocked by weight and randomly allotted to 30 pens (10 pens/block; 5 hd/pen) in a 180-d finishing study. Two pens/block were assigned to one of five implant treatments. Treatments were: 1) no implant (NC); 2) implant d 0; 3) two implants d 0; 4) implant d 0 and reimplant d 94; and 5) implant d 0, explant and reimplant d 94. All implants were a combination of estradiol (24 mg) and trenbolone acetate (120 mg). Overall daily gain was 13.5% greater ( $P < .001$ ) for implanted steers compared with NC steers, and was 7.2% greater ( $P = .02$ ) in steers with two implants vs one implant. Overall DMI tended to be greater ( $P = .06$ ) in implanted compared with NC steers, whereas DMI did not differ ( $P > .70$ ) among implanted steers. Similar to daily gain, implanted steers had greater ( $P = .008$ ) gain:DMI than control steers (.171 vs .158 ± .004), and steers receiving two implants had greater ( $P = .03$ ) gain:DMI than steers receiving one implant (.174 vs .163 ± .004). Implanted steers yielded 20 kg more HCW than NC steers. No differences ( $P > .10$ ) were observed among treatments for skeletal maturity, lean maturity, ribeye area, marbling score, or quality grade. Yield grade was lower ( $P = .03$ ) in steers implanted with two implants on d 0 compared with steers implanted on d 0 and reimplanted on d 94. Implanting twice resulted in greater performance and carcass weight compared with implanting once. In general, performance and carcass traits are similar in steers implanted twice on d 0 compared with steers implanted on d 0 and reimplanted later in the feeding period.

**Key Words:** Implants, Performance, Carcass Traits

### 319 Effect of corn type and implant status on feedlot performance and carcass characteristics of beef steers. M.S. Eibs\*<sup>1</sup>, B.J. Johnson<sup>2</sup>, and B.D. Rops<sup>1</sup>, <sup>1</sup>South Dakota State University, <sup>2</sup>Kansas State University.

Objectives of these experiments were to investigate the effects of a Revalor-S® (Rev) implant (120 mg trenbolone acetate and 24 mg estradiol) on feedlot performance and carcass characteristics of steers fed a high oil corn based diet. Angus-sired steer calves ( $n=159$ , initial BW = 391 8.14 kg), were allotted by weight to treatment: 1) rolled corn (C: 79.5% of ration) without Rev (CN); 2) rolled high oil corn (HOC: 79.5% of ration) without Rev (HN); or 3) rolled high oil corn (HOC: 79.5% of ration) with Rev (HI), for 112 days. Cattle were harvested at a commercial packing plant. Carcass data were retrieved 24 h postmortem. Cumulative ADG differed ( $P < .05$ ) between HI and CN, HN (1.66 vs 1.44 and 1.47 kg/d) and feed to gain (F/G) (6.07 vs 6.72 and 6.95). Cumulative DMI were not different ( $P > .05$ ) (10.02 vs 9.74 and 9.76 kg/d). HI cattle had heavier ( $P < .05$ ) hot carcass weights and more ribfat ( $P < .05$ ) and consequently a higher ( $P < .05$ ) USDA yield grade compared to CN and HN (3.40 vs 3.19 and 3.15). HI had a greater percentage of USDA Select carcasses ( $P < .05$ ) compared to CN and HN (15% vs 0% and 0%), using chi-square distribution. CN and HN were not different ( $P > .05$ ) for feedlot performance and carcass characteristics. Color readings were taken 24 h postmortem on the longissimus muscle exposed between the 12th and 13th rib with a Minolta Chroma Meter CR-310. CN had less redness indicated by lower  $a^*$  readings ( $P < .05$ ) compared to HN and HI (22.05 vs 22.38 and 22.33), and lower  $b^*$  values compared to HI ( $P < .05$ ), but not HN ( $P > .05$ ) (14.33 vs 14.55 and 14.47). These data suggest that Revalor-S elicits a similar response in feedlot performance for cattle fed high oil corn as compared to the literature for control corn. Furthermore, high oil corn did not affect feedlot performance or carcass characteristics compared to steers fed control corn.

**Key Words:** Beef, High Oil Corn, Growth Implants

### 320 Feeding value of Bt corn grain compared with its parental hybrid when fed in beef cattle finishing diets. A.T. Petty\*<sup>1</sup>, K.S. Hendrix<sup>1</sup>, E.P. Stanisiewski<sup>2</sup>, and G.F. Hartnell<sup>2</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, <sup>2</sup>Monsanto Company, St. Louis, MO.

The objective was to determine the effect of Bt corn on the performance of steer calves fed whole plant corn silage (WPS) during the growing phase followed by a high grain finishing diet. During the 1998 (yr 1) and 1999 (yr 2) cropping seasons, alternating 6.8 ha fields (8 in yr 1 and 6 in yr 2) were planted to either Bt (Yieldgard®) or the near isogenic parental hybrid (Pioneer 3489 in yr 1 and Pioneer 34E79 in yr 2). Prior to harvest, perimeter rows were removed to reduce the possibility of feeding cross-pollinated hybrids. Fifty-six Angus and Simmental sired steer calves (300 kg), 1 month postweaning, were randomly allotted by weight and breed type into eight pens of seven steers. They were fed the WPS diet for 89 d in yr 1 and 85 d in yr 2. The finishing diet contained 75% dry rolled corn, 15% whole plant corn silage, and 10% suppl. on a DM basis. The finishing phase was 101 d in yr 1 and 84 d in yr 2. During the WPS phase of yr 1, ADG and DMI did not differ ( $P > .05$ ) between groups while feed/gain averaged 7.08 and 6.40 between Bt and control steers ( $P < .05$ ). Steer performance during the WPS phase of yr 2 did not differ ( $P > .05$ ). There were no significant differences in ADG, DMI, or feed/gain during the finishing phases ( $P > .05$ ). Combining the yr 1 WPS and finishing phases, ADG averaged 3.18 and 3.30 kg/d ( $P > .05$ ), DMI averaged 9.80 and 9.71 kg/d ( $P > .05$ ), and feed/gain averaged 6.78 and 6.47 ( $P < .05$ ) among Bt and control steers. There were no overall performance differences ( $P > .05$ ) during yr 2 (ADG, 3.14 vs 3.21 kg/d; DMI, 9.52 vs 9.79 kg/d; and feed/gain, 6.66 vs 6.72). Steers were harvested on multiple dates when it was estimated that 75% of a load would grade USDA Choice. There were no differences in carcass characteristics ( $P > .05$ ). Results indicate that there are no major differences in the feeding value of grain from Bt corn and the near isogenic parental hybrid when fed to beef steers on a high grain finishing diet.

**Key Words:** Bt Corn, Corn Types, Beef

**321 Performance of beef cattle fed Roundup Ready<sup>®</sup> corn harvested as whole plant silage or grain.** A.T. Petty\*<sup>1</sup>, K.S. Hendrix<sup>1</sup>, E.P. Stanisiewski<sup>2</sup>, and G.F. Hartnell<sup>2</sup>, <sup>1</sup>Purdue University, West Lafayette, IN, <sup>2</sup>Monsanto Company, St. Louis, MO.

The objective was to determine the effect of Roundup Ready<sup>®</sup> (RR) corn on performance of steer calves fed whole plant silage (WPS) and grain. This was accomplished by having an 85 d WPS feeding phase followed by an 84 d finishing phase. Alternating plots of a 20.25 ha field were planted with either RR (DK626RR) or its near isogenic parental hybrid (DK626). Prior to harvest, perimeter rows were removed to reduce the possibility of feeding cross-pollinated hybrids. Approximately half of each plot was harvested as WPS and the remainder harvested later as grain. Fifty-six Angus and Simmental sired steer calves (304 kg) were randomly allotted by weight and breed type into eight pens of seven steers. Four pens were fed a diet containing 90% WPS from either corn type and 10% suppl. on a DM basis. Steers remained on the WPS diet for 85 d. After the WPS phase, steers were gradually changed to a finishing diet of the same corn type. This diet contained 75% dry rolled corn, 15% WPS, and 10% suppl. on a DM basis. Steers remained on the finishing diet for 84 d. During the WPS phase, ADG (1.38 vs 1.40 kg/d), DMI (9.35 vs 9.57 kg/d), and feed/gain (6.79 vs 6.85) for steers fed RR or control WPS, respectively, were not different ( $P > .10$ ). During the finishing phase, ADG (1.45 vs 1.47 kg/d), DMI (10.10 vs 10.11 kg/d), and feed/gain (7.02 vs 6.87) for steers fed RR or control diets, respectively, were not different ( $P > .10$ ). Combining the WPS and finishing phases, ADG (1.41 vs 1.43 kg/d), DMI (9.73 vs 9.84 kg/d), and feed/gain (6.90 vs 6.86) for steers fed RR or control diets, respectively, were not different ( $P > .10$ ). Steers remained on the same finishing ration and were harvested on multiple dates when it was estimated that 75% of a load would grade USDA Choice. There were no differences in carcass characteristics ( $P > .10$ ). Results indicate that there is no difference in feeding value of WPS or grain from RR corn and the near isogenic parental hybrid when fed to growing and finishing beef cattle.

**Key Words:** Roundup Ready, Corn Types, Beef

**322 Effects of a slow-release urea product on performance and carcass characteristics of feedlot cattle.** G. C. Duff\*, D. A. Walker, K. J. Malcolm-Callis, M. W. Wiseman, and J. D. Rivera, Clayton Livestock Research Center, New Mexico State University.

Two studies were conducted to evaluate effects of a slow-release urea product (RumaPro<sup>®</sup>) on performance and carcass characteristics of beef steers. In Exp. 1, 200 crossbred steers (Continental x British; initial BW = 331 kg) were used. Treatments were 90% concentrate diets (13.5% CP) and included as supplemental CP sources: soybean meal (SBM), RumaPro (RUMA), a 50:50 mixture of SBM and RUMA (MIX), or urea (U). Steers were stratified by BW into five weight blocks (four pens per block) with five pens (10 steers/pen) per treatment for a total of 20 pens. No differences ( $P > 0.10$ ) were noted for ADG, daily DMI, or gain:feed for the overall feeding period. No differences ( $P > 0.10$ ) among treatments were noted for dressing percentage, longissimus muscle area, marbling score, yield grade, or internal fat. Hot carcass weight was increased ( $P < 0.10$ ) for the average of RUMA, MIX, and U compared with SBM. Fat thickness was increased ( $P < 0.05$ ) for the average of RUMA, MIX, and U compared with SBM, increased ( $P < 0.05$ ) for RUMA compared with MIX, and increased ( $P < 0.05$ ) for the average of RUMA and MIX compared with U. In Exp. 2, 89 crossbred steers (Continental x British; initial BW = 353 kg) were used. Steers were stratified by BW and assigned to three weight blocks (three pens/weight block). Treatments (three pens/ treatment) included SBM as the supplemental CP source, a 50:50 mixture of RumaPro and SBM, or 100% RumaPro. A total of nine pens were used in Exp. 2. No differences ( $P > 0.10$ ) were noted among treatments for ADG, daily DMI, or gain:feed for the overall feeding period. No differences ( $P > 0.10$ ) were noted among treatments for carcass characteristics. Results suggest no improvement in performance with a slow-release urea product compared with either soybean meal or urea.

**Key Words:** Beef Cattle, Slow-Release Urea, Performance

**323 Effect of corn and barley processing on performance of steers fed wet corn gluten feed (WCGF) based diets.** E. R. Loe\*<sup>1</sup>, M. L. Bauer<sup>1</sup>, G. P. Lardy<sup>1</sup>, and R. A. Stock<sup>2</sup>, <sup>1</sup>North Dakota State University, Fargo, <sup>2</sup>Cargill Corn Milling, Blair, NE.

Dry-rolled processing corn and barley in WCGF-based diets was evaluated using 144 crossbred steers (315.7 ± 1.5 kg initial BW) fed for 159 d (1 pen/treatment) and 182 d (5 pens/treatment). Steers were blocked by weight and allotted randomly to dietary treatment (6 pens/treatment). Treatments were fine-rolled corn (FRC), coarse-rolled corn (CRC), fine-rolled barley (FRB), and coarse-rolled barley (CRB). Diets contained 50% WCGF, 42% grain (corn or barley), 5% alfalfa hay, and 3% supplement containing 27.5 mg/kg monensin and 11 mg/kg tylosin. All diets were formulated to contain a minimum 14.4% CP, .8% Ca, .7% P, and 1.0% K. Initial weight was an average of three consecutive day weights. Grain samples were taken weekly for analysis of particle size. Data was analyzed as a 2 x 2 factorial arrangement of treatments with GLM procedure of SAS. There were no grain x processing interactions ( $P > .41$ ). Particle size was 2145 60, 2588 58, and 3090 95  $\mu$ m for fine-rolled, coarse-rolled, and whole-barley and 1899 61, 3232 77, and 3932 268  $\mu$ m for fine-rolled, coarse-rolled, and whole-corn. Corn-fed steers had heavier final weights, increased ADG, increased feed efficiency, heavier HCW, larger REA, increased fat thickness, higher yield grade, increased marbling, and greater KPH vs barley-fed steers ( $P < .04$ ). Fine-rolling grain increased fat thickness ( $P = .04$ ) and yield grade ( $P = .07$ ). There were no other measurements affected by treatment ( $P > .14$ ). Corn-fed steers were more efficient than barley-fed steers. Reducing grain particle size (82.2 to 48.3% and 83.7 to 69.4% of whole corn and barley) does not greatly affect performance of steers fed WCGF-based diets.

Item	FRC	CRC	FRB	CRB	SEM
Final wt, kg	648.2	634.3	601.3	597.0	7.2
ADG, kg	1.86	1.79	1.60	1.58	.04
DMI, kg/d	10.68	10.25	10.28	9.82	.29
Gain:Feed, kg:kg	.175	.175	.156	.162	.003
HCW, kg	401.9	393.3	372.8	370.2	4.5
Fat thickness, cm	1.30	1.17	1.07	1.00	.05
Marbling	447	452	413	399	14
Yield grade	3.09	2.93	2.78	2.69	.06

**Key Words:** Grain, Processing, Steers

**324 Utilization of malting industry byproducts on cattle feedlot diets.** C.R. Dahlen<sup>1</sup>, C.M. Zehnder\*<sup>1</sup>, D. Ziegler<sup>2</sup>, A. DiCostanzo<sup>1</sup>, L.R. Miller<sup>1</sup>, H. Chester-Jones<sup>2</sup>, and G.C. Lamb<sup>3</sup>, <sup>1</sup>University of Minnesota, St. Paul, <sup>2</sup>Southern Research and Outreach Center, Waseca, <sup>3</sup>North Central Research and Outreach Center, Grand Rapids.

Eighty crossbred steers (434 kg) were used to study effects of malting industry byproducts (BP) on performance and carcass characteristics. Steers were allocated within weight classes (heavy or light) to one of 16 pens. Pens were randomly assigned to one of four dietary treatments: 1) corn grain (CG)-corn silage (CSL)-based diet (78% CG, 16% CSL, 6% Supplement (Supp); Control); 2) CG-corn gluten feed (CGF)-based diet (66% CG, 11% CSL, 20% CGF, 3% Supp; CGF-Control); 3) CG-BP diet (64% CG, 13% CSL, 20% BP, 3% Supp; MBP); or 4) CG-BP and thin stillage (TS) diet (55% CG, 21% CSL, 14% BP, 7% TS, 3% Supp; MBPTS). Diets were formulated to contain .62 Mcal NE<sub>g</sub>, 12.5% CP, .6% Ca and .4% P. Feed was mixed in a stationary mixer and delivered according to bunk calls for the preceding 3 d to achieve ad libitum intake. Initial weights were taken after a 14 h shrink. Final weight was estimated from hot carcass weight divided by a dressing percentage of 63%. Steers were implanted once with Component T-S<sup>®</sup> based on projected slaughter date (98 or 97 d before slaughter for heavy or light block, respectively). Steers fed MBP or MBPTS tended ( $P = .09$ ) to have lower ADG than those fed the Control or CGF-Control diets (1.83, 1.70, 1.61, 1.66 kg/hd/d for steers fed Control, CGF-Control, MBP, or MBPTS diets, respectively). There were no effects ( $P > .10$ ) of diet on DMI (10.92, 10.36, 11.19, 11.00 kg/hd/d for steers fed Control, CGF-Control, MBP, or MBPTS diets, respectively). Steers fed MBP or MBPTS diets required more ( $P < .05$ ) DM/kg gain than those fed Control or CGF-Control diets (5.97, 6.10, 6.93, 6.62 for steers fed Control, CGF-Control, MBP, or MBPTS diets, respectively). Diet did not ( $P > .10$ ) influence carcass traits. Results indicate that substituting CSL or CGF with BP alone or in combination with TS led to slightly



depressed ADG and reduced feed efficiency. Thus, opportunity price of BP is 86.7% the price of corn gluten feed.

**Key Words:** Byproduct, Malting, Steer

**325 Phosphorus requirements of finishing steer calves.** G. E. Erickson<sup>\*1</sup>, T. J. Klopfenstein<sup>1</sup>, M. W. Orth<sup>2</sup>, D. Brink<sup>1</sup>, and K. M. Whittet<sup>1</sup>, <sup>1</sup>University of Nebraska, Lincoln, <sup>2</sup>Michigan State University.

Forty-five steer calves (BW=265±16.9kg) were individually fed diets containing either .18, .24, .30, .36, or .42 P as % diet DM (n=9) to determine the P required for optimal performance. Supplemental phosphorus from NaH<sub>2</sub>PO<sub>4</sub> replaced basal diet consisting of 33.5% high-moisture corn, 30% degermed corn grits, 20% corn bran, 7.5% cottonseed hulls, 3% tallow, and 6% supplement. Total P intakes ranged from 15.9 to 37.3 g per d for the 204 d. Animal performance and carcass characteristics were not influenced (P>.20) by dietary P treatment. Blood was collected on d0, d56, d112, d168, and d204. Inorganic plasma P analysis suggested a quadratic response to P treatment when averaged from d56 to d204. Osteocalcin, an indicator of bone formation in plasma, was not different (P>.33) between the .18 and .42% P treatments suggesting that bone turnover was not impacted by dietary treatment. However, phalanx bone ash tended (P=.08) to respond similar to plasma P when expressed as a percentage of carcass weight. Based on performance data, P requirements for finishing calves is lower than .18% dietary P or 16 g per d.

Item	.18	.24	.30	.36	.42	SE	Lin <sup>a</sup>	Quad <sup>a</sup>
P intake, g/d	15.9	22.0	25.1	33.5	37.3	.7	.01	
ADG, kg/d	1.52	1.53	1.34	1.61	1.47	.01	.86	.28
Gain:Feed <sup>b</sup>	.171	.171	.163	.174	.166	.004	.63	.80
Plasma P, mg/dL	5.71	6.95	6.89	7.19	6.55	.12	.01	.01
Phalanx bone								
total ash, g	27.8	29.3	27.8	30.9	27.6	1.1	.72	.23
ash, g/100kg carcass	7.9	8.2	8.3	8.4	7.9	.2	.87	.08

<sup>a</sup>Linear and Quadratic contrasts <sup>b</sup>Gain:Feed measured as ADG/DM intake

**Key Words:** Phosphorus, Requirement, Feedlot Calves

**326 Soy products as protein sources for beef and dairy cattle.** J. L. Firkins<sup>\*</sup> and F. L. Fluharty, *The Ohio State University.*

Extensive amounts of dietary protein are degraded in the rumen, and several reviews have characterized the degradability of various protein sources. Methods to treat soybean meal (SBM) to reduce ruminal degradability will be discussed relative to effectiveness and to growth and lactation performance. Considerable amounts of variation remain unexplained regarding the degradability of different batches of the same protein sources, including soy products, or in the proteolysis among different animals fed the same diets. Despite the need for further work explaining animal-to-animal variation, to standardize appropriate processing conditions, and to develop methods to characterize degradability of protein and amino acids among protein sources, some general feeding situations will be discussed, particularly with reference to use of SBM. Increasing the amount of lysine and methionine from ruminally undegraded protein (RUP) seems especially effective for transition dairy cows. Receiving beef cattle also can benefit from greater supplies of metabolizable lysine and methionine. Increasing the amount of concentrate and feeding ionophores decrease the SBM protein degradability, decreasing the response to sources of RUP. Because of the limitation in available energy for microbial protein synthesis in the rumen, RUP could be limited for cattle fed higher forage diets. Although numerous reports have compared SBM to that treated to increase RUP, much less consideration has been given to lysine availability of the treated sources or to the potential for methionine or other amino acids to be limiting, reducing or even negating the response to the treated SBM sources. Because of concern to reduce N loss from beef and dairy operations, the supply of amino acids needs to be optimized by rumen models that evaluate RUP sources and rumen-protected amino acids relative to carbohydrate availability in the rumen. Treated SBM probably will have an increasing role in this optimization process.

**Key Words:** Soybean Meal, Rumen Undegraded Protein, Cattle

**327 Utilization of whole soybeans in dairy cattle diets.** R. Grummer<sup>\*</sup> and E. Rabelo, *University of Wisconsin, Madison.*

Dairy cows typically do not consume sufficient protein and energy in early lactation to meet requirements for maintenance and milk production. Consequently they mobilize protein and lipid to support lactation. The high protein and energy content of whole soybeans makes them an attractive supplement to diets fed to lactating dairy cows. Appropriate heat treatment enhances the nutritive value of soybeans by increasing the rumen undegradable protein (RUP) content and possibly post-ruminal digestibility. Target RUP content of heated soybeans is 60% of crude protein which can be obtained by a residence time in a roaster of one minute, exit temperature of 146°C, and steeping for 30 min. A summary of the literature indicated that the average increase in milk and fat-corrected milk production was 1.6 and 1.4 kg/d when feeding roasted soybeans and 1.7 and .4 kg/d when feeding extruded soybeans. Milk fat depression averaged -.25 percentage units when feeding extruded soybeans. Lactation response to supplementation of heated soybeans is dependent on type of forage in the diet. A summary of research trials indicated an average milk yield response of 3.1, .9 and 1.7 kg/d when alfalfa, corn silage, or a mixture of alfalfa and corn silage were fed as forages. Milk fat depression is more likely if heated soybeans are fed with corn silage rather than alfalfa as the sole forage source. Potential concerns when feeding high amounts of polyunsaturated fatty acid as whole soybeans include depressed fiber digestion and excessive formation of trans C18:1 fatty acids in the rumen. A review of the literature did not support the former. Evaluation of the effects of fat from soybeans on lactation performance is difficult because of potential confounding effects of heat treatment or anti-nutritional factors when comparing heated or raw soybeans to soybean meal. Feeding whole soybeans may decrease the proportion of short and medium chain fatty acids and increase the proportion of C18:0, C18:1 (including trans isomers), and conjugated linoleic acid in milk fat.

**Key Words:** Dairy Cattle, Whole Soybeans, Lactation

**328 Soy by-products as energy sources for beef and dairy cattle.** E. C. Titgemeyer<sup>\*</sup>, *Kansas State University, Manhattan.*

The use of soybean hulls as an energy source for beef and dairy diets will be reviewed. Digestion of soybean hulls is impacted by a number of dietary factors, and soybean hulls also can influence digestion of other dietary components. Soybean hulls may lead to fewer negative associative effects than starch-based supplements, but the effective fiber of soybean hulls is low such that they are most efficaciously used in diets containing adequate forage. In a broad range of in vitro and in situ experiments, soybean hulls have been found to be digested rapidly and extensively. Despite this, digestion of soybean hulls is often much less in vivo than in vitro, suggesting that passage of soybean hulls from the rumen is rapid. As a supplement for forage-based diets, soybean hulls often decrease forage intake, but total diet intakes and total diet digestibilities are generally increased. Soybean hulls can be valuable in dairy diets by acting as a energy-dense feed that leads to a fermentation high in acetate. However, soybean hulls do not stimulate chewing activity greatly, and thus do not elevate ruminal pH as does forage. When evaluating the impact of including soybean hulls in dairy diets, it is important to consider the energy content of feeds replaced by soybean hulls, the adequacy of effective fiber, and the magnitude of negative associative effects in the diet before as well as after the addition of soybean hulls.

**Key Words:** Soybean Hulls, Cattle, Associative Effects

**329 Neutral detergent fiber concentration of corn silage and rumen inert bulk influences dry matter intake and ruminal digesta kinetics of growing steers.** K. E. Tjardes<sup>\*</sup>, D. D. Buskirk, M. S. Allen, and N. K. Ames, *Michigan State University, East Lansing.*

The concentration of NDF in corn silage ranges from 30 to 60%. Corn silage with high fiber concentration has the potential to reduce DMI by increasing ruminal fill. Our objective was to challenge light-weight growing steers with ruminal fill, in the form of dietary fiber and inert bulk, to determine if high NDF corn silage-based diets limit intake. Eight ruminally cannulated Holstein steers (198 ± 13 kg) were randomly assigned to a 2 × 2 factorial arrangement of treatments in a replicated 4

× 4 Latin square design. Steers had ad libitum access to a low- (33.8% NDF) or high-fiber (50.8% NDF) corn silage-based diet with or without rumen inert bulk (RIB). RIB was added at 25% of pretrial ruminal volume in the form of plastic-coated tennis balls (7.5 L; 1.1 specific gravity). No fiber inert bulk interactions were detected ( $P > 0.10$ ). Increasing dietary concentration of NDF depressed DMI by an average of 15.5% ( $P < 0.001$ ). Addition of inert bulk decreased DMI 60 and 71 g/L of RIB for the low- and high-fiber diets, respectively ( $P < 0.001$ ). High levels of dietary fiber increased NDF intake and reduced ruminal NDF turnover time ( $P < 0.001$ ) with no effect on ruminal volume or amount of ruminal NDF ( $P > 0.10$ ). The addition of RIB also reduced ruminal NDF turnover time ( $P < 0.001$ ) with no change in ruminal volume ( $P > 0.10$ ). High level of dietary fiber decreased digestibility of DM and GE, but increased NDF digestibility ( $P < 0.001$ ). RIB had no effect on digestibility of DM, NDF, or GE ( $P > 0.10$ ). Results from this trial suggest that DMI of light-weight steers receiving corn-silage based diets can be limited by physical fill by both the low and high NDF corn silage.

Item	Low Fiber		High Fiber		SEM	Effect <sup>a</sup>	
	CON <sup>b</sup>	RIB <sup>b</sup>	CON <sup>b</sup>	RIB <sup>b</sup>		F	B
DMI, kg/d	4.92	4.47	4.23	3.70	0.14	***	***
NDF intake, kg/d	1.66	1.51	2.51	1.88	0.06	***	***
Digesta volume, L	28.7	28.0	29.1	27.6	2.14	NS	NS
Digesta weight, kg	3.16	2.78	3.02	2.50	0.20	*	***
Digesta NDF, kg	1.78	1.46	1.84	1.41	0.13	NS	***
NDF turnover time, h	25.9	23.2	20.8	18.0	1.40	***	**
Total-tract digestibility							
DM, %	70.1	69.6	65.6	63.2	0.87	***	NS
NDF, % DM	47.8	46.0	58.8	55.7	1.35	***	NS
GE, % DM	69.6	69.3	65.0	62.6	0.87	***	NS

<sup>a</sup>CON = no rumen inert bulk; RIB = rumen inert bulk. <sup>b</sup>F = fiber; B = bulk; NS = nonsignificant; \* $P < 0.05$ ; \*\* $P < 0.01$ ; \*\*\* $P < 0.001$ .

**Key Words:** Fiber Level, Physical Fill, Holstein Steers

**330 Management strategies and live weight gain of steers grazing Old World bluestem.** P.D. Kircher<sup>\*1</sup>, H.T. Purvis II<sup>1</sup>, G.W. Horn<sup>1</sup>, C.J. Ackerman<sup>2</sup>, T.N. Bodine<sup>1</sup>, and D.A. Cox<sup>1</sup>, <sup>1</sup>Oklahoma Agriculture Experiment Station, Stillwater, <sup>2</sup>Oregon State University, Corvallis.

Three hundred and sixty crossbred steers (248–24 kg) were used to determine the effects of management system on animal performance. Steers were weighed and allotted in a completely randomized design to one of four treatments with three replicates per treatment on May 12. Treatments were, 1) intensive early stocking (IES; stocking density of 1344 kg/ha and a 65d grazing season); 2) half intensive early stocking (HIES; 672 kg/ha, 65d of grazing); 3) season long (SL; 672 kg/ha, 134d of grazing); and 4) season long supplemented (SLS; same stocking density as SL and fed 0.59 kg/steer<sup>-1</sup>·d<sup>-1</sup> of a 31% CP supplement prorated for 3x/week feeding from July 18–Sept. 24). The IES treatment had a lower BW ( $P < 0.01$ ) than HIES, SL, and SLS at the end of the early period (May 12 - July 17; 300 vs 313, 315, and 316 kg). At the end of grazing trial SL and SLS were similar ( $P = .21$ ) in BW (361, 369 kg). Early period ADG was similar ( $P = 0.42$ ) for SL, SLS, and HIES (1.02, 1.03, and 1.06 kg/d) and greater ( $P < 0.01$ ) than IES (0.72 kg/d). However, IES steers had greater ( $P < 0.01$ ) gain/ha (104 kg/ha) and reduced ( $P < 0.01$ ) gain/steer (47 kg) in the early period than SL, SLS, and HIES. In the late period (July 18 - Sept. 24) SLS cattle had greater ( $P < 0.02$ ) ADG (0.78 vs 0.67 kg/d), gain/ha (58 vs 51 kg/ha), and gain/steer (53 vs 46 kg) than SL. Gain/ha (127 vs 133 kg/ha) for the entire grazing period was similar ( $P = 0.41$ ) for SL and SLS. Gain/steer (121 vs 113 kg) and ADG (0.90 vs 0.84 kg/d) for the entire grazing period tended ( $P > 0.10$ ) to be greater for SLS than SL. Gain/ha by IES steers during the early grazing period was 80% of the total gain/ha of SL and SLS during the entire grazing period. Intensive early stocking was an effective management tool for maximizing gain/ha during the early grazing period,

while supplementation during late summer grazing tended to improve individual steer performance.

**Key Words:** Growing Cattle, Old World Bluestem, Grazing

**331 Effect of winter gain on summer forage intake, summer gain, and finishing performance.** D. J. Jordan<sup>\*</sup>, T. J. Klopfenstein, D. C. Adams, C. T. Milton, R. J. Cooper, D. Downs, and G. E. Erickson, *University of Nebraska*.

Two trials were conducted over four yr. In trial 1, 2-yr of data were collected to determine the effect of winter gain on summer forage intake, summer gain, and finishing performance. The treatment arrangement was a 2 × 2 × 2 factorial with yr, rate of winter gain, and summer location as factors. Steers were wintered at either a faster rate of gain using wet corn gluten feed (WCGF) as an energy source (FAST) or a slower rate of gain (SLOW). Forage intake was determined using an intra-ruminal chromium bolus. No differences were noted for forage intake between FAST and SLOW; however, as a percentage of body weight, steers on the SLOW treatment consumed more ( $P < 0.05$ ) than FAST. Compensation of weight over the summer was 17 and 48% in yr 1 and 2, respectively. Increased forage intake, as a percentage of body weight, likely accounted for at least some of the compensation. In the feedlot, FAST gained more ( $P < 0.05$ ), consumed more feed ( $P < 0.05$ ), but was similar in efficiency compared to SLOW. In trial 2, two yr of data were collected to determine the impact of duration and severity of winter feed restriction on compensatory growth on grass and to evaluate slaughter breakevens of wintering systems. Three additional treatments were added (in addition to FAST and SLOW) in trial 2. Steers were fed corn over the winter to increase gain (CORN), steers were grown at a faster rate of gain for the first half of the winter using WCGF followed by a slower rate of gain for the second half (FAST/SLOW), and vice versa (SLOW/FAST). During the summer, compensation ranged from 24–33% for SLOW, FAST/SLOW, and SLOW/FAST compared to FAST. No differences were noted in feedlot performance. For slaughter breakeven, FAST was lower compared FAST/SLOW and SLOW, but was similar to CORN and SLOW/FAST. To equalize breakeven with FAST, 55–65% compensation would be required by steers on the intermediate and SLOW treatments. Steers should be fed at increased rates over the winter to reduce slaughter breakeven.

**Key Words:** Forage Intake, Slaughter Breakeven, Compensatory Growth

**332 Effects of implant status during winter and summer grazing periods on performance of stocker steers.** T. N. Bodine<sup>\*</sup>, H. T. Purvis II, D. A. Cox, G. W. Horn, and C. R. Krehbiel, *Oklahoma Agricultural Experiment Station, Stillwater*.

Eighty-five weaned steers (213 ± 4 kg) from a single ranch were used to determine the effects of an implant during winter and subsequent summer grazing, and to detect carryover effects of previous implant status during winter grazing on rate of gain during summer grazing. During the winter grazing period (December–March; 92 d), steers had an implant of Synovex-S<sup>®</sup> (WIN+; n=43) or no implant (WIN0; n=42), were supplemented 3X/week with 2 kg of a 38% CP cube/steer/feeding, and were allowed to graze dormant Old World bluestem. In April, steers (238 ± 4 kg) in either treatment were implanted with Synovex-S (SUM+) or not implanted (SUM0), were supplemented 3X/week with 2 kg/steer/feeding, and grazed native tallgrass prairie for 151 d. Experimental design was a CRD with a 2 × 2 factorial arrangement of treatments. No interactions were detected ( $P > 0.40$ ) between winter and summer implant status for any of the measured variables so only main effects are reported. Steers implanted during winter grazing had increased ( $P = 0.10$ ) ADG vs WIN0 steers (0.38 vs 0.33 kg). Summer ADG was increased ( $P < 0.04$ ) for SUM+ steers (0.96 kg) compared with SUM0 steers (0.90 kg). Cattle implanted during winter grazing had reduced ( $P < 0.06$ ) summer ADG (0.90 vs 0.96 kg) vs WIN0 steers. Daily gains across the entire grazing period (WIN and SUM, 269 d) tended ( $P = 0.10$ ) to be greater for SUM+ (0.63 kg) vs SUM0 (0.60 kg) steers and were not different ( $P = 0.40$ ) for WIN+ (0.61 kg) vs WIN0 (0.62 kg) cattle. The use of a Synovex-S implant increased live-weight gain in either the winter or summer grazing seasons. It appears that when summer gains are relatively high, the summer grazing period is the most effective time to implant, and may be more effective than implanting in both winter and summer.

**Key Words:** Implants, Carryover Effects, Grazing Steers

**333 Effects of implant status during winter grazing and rate of gain during summer grazing on performance by stocker steers.** T. N. Bodine\*, H. T. Purvis, D. A. Cox, G. W. Horn, and C. R. Krehbiel, *Oklahoma Agricultural Experiment Station, Stillwater.*

Eighty-three steers ( $217 \pm 4$  kg) were used to determine the effects of an implant during the winter grazing season (Dec-Mar, 92d) and to detect if carryover effects of the winter implant varied with rate of gain during summer grazing (Apr-Sept, 151d). Steers were implanted with Synovex-S® (WIN+; n=42) or no implant (WIN0; n=41), supplemented 3X/week with 2 kg of a 38% CP cube/steer/feeding, and allowed to graze dormant Old World bluestem during the winter. In April, steers ( $240 \pm 4$  kg) were implanted with Synovex-S. To create different rates of gain (LOW vs HIGH), steers were stocked at 100 AUD/ha (n=4; LOW) with no supplemental feed, or 60 AUD/ha (n=4; HIGH) and supplemented 3X/week with 2 kg/steer/feeding, and allowed to graze native tallgrass prairie pastures. Interactions ( $P < 0.06$ ) between winter implant status and summer rate of gain were detected for summer and total (Dec-Sept, 269 d) ADG. Implanting during winter grazing increased ( $P < 0.09$ ) ADG ( $0.4$  vs  $0.3$  kg). Summer ADG for steers at the LOW rate of gain did not differ ( $P = 0.19$ ) for WIN+ ( $0.68$  kg) vs WIN0 ( $0.63$  kg) cattle. Steers at the HIGH rate of gain on the WIN+ ( $0.93$  kg) and WIN0 ( $0.99$  kg) treatments had similar ( $P = 0.12$ ) summer ADG, and were greater ( $P < 0.01$ ) than WIN+ or WIN0 steers at the LOW rate. Daily gain for the entire grazing period (WIN and SUM) by steers at the LOW rate of summer gain tended ( $P < 0.07$ ) to be greater for WIN+ ( $0.47$  kg) vs WIN0 ( $0.43$  kg), while cattle at the HIGH rate did not differ between ( $P = 0.33$ ) WIN+ ( $0.62$  kg) vs WIN0 ( $0.64$  kg). Both WIN+ and WIN0 steers at the HIGH rate of summer gain had greater ( $P < 0.01$ ) total grazing period ADG than either treatment at the LOW rate. Use of a Synovex-S implant increased winter grazing ADG. Steers implanted during winter grazing with a reduced rate of gain in the summer tended to maintain their advantage over the total grazing period. However, carryover effects of an implant during winter grazing were not affected by rate of gain during summer grazing.

**Key Words:** Implants, Rate of Gain, Grazing Steers

**334 Undegradable intake protein supplementation of March- and June-born steers previously wintered at two rates of gain.** A. M. Hopkin\*, D. C. Adams, T. J. Klopfenstein, and R. T. Clark, *University of Nebraska, Lincoln.*

Two experiments were conducted to evaluate the response of undegradable intake protein (UIP) supplementation in March- and June-born steers previously wintered at two rates of gain. In Experiment 1 (1999), March-born (MAR, n=29) and June-born (JUN, n=62) steers were allotted to two rates of gain during winter: high (H, .69 kg/d) and low (L, .38 kg/d). JUN steers were then allotted to two summer protein treatments: supplemental UIP (S) or no supplemental UIP (NS). All steers grazed subirrigated meadow from Apr 30 to May 31 and upland Sandhills range from Jun 1 to Sep 9. S steers were individually fed supplements from Jun 7 to Sep 8. In Experiment 2 (2000), 114 steers were used in a 2x2x2 factorial arrangement of treatments. MAR (n=60) and JUN (n=54) steers were randomly assigned to one of two rates of winter gain: high (.55 kg/d) and low (.37 kg/d). Steers were then assigned to one of two summer treatments as in Exp. 1. Steers grazed subirrigated meadow from May 2 to May 29 and upland range from May 30 to Aug 23; steers were individually fed supplements from Jun 5 to Aug 18. In Exp. 1, ADG on the meadow was .56 kg/d higher ( $P < .01$ ) for both MAR and JUN steers that were wintered at the low rate of gain. Additionally, JUN steers grazing upland range showed a positive response to UIP supplement ( $P < .01$ ) regardless of previous winter gain. For NS steers during the grazing period, steers on L winter gain had higher ADG ( $P < .01$ ) than H steers as a result of compensatory gain. In Exp. 2, ADG on meadow was higher for MAR steers ( $P = .05$ ) and H winter gain ( $P = .02$ ) than JUN and L steers respectively. However, ADG on range was higher ( $P < .01$ ) for L steers. For the entire grazing period, steers on L winter gain had higher ADG ( $P < .01$ ) than steers on H winter gain and S steers experienced higher ADG ( $P < .01$ ) than NS steers. Response to UIP supplementation (.13 kg/d) was not affected by rate of previous winter gain. Compensatory gain experienced in the low winter gain steers persisted throughout the grazing period.

**Key Words:** Undegradable Intake Protein, Compensatory Gain

**335 Excess crude protein and creep feeding affects growth and subsequent maternal characteristics of beef heifers.** W. J. Sexten\*, D. B. Faulkner, J. M. Dahlquist, and F. A. Ireland, *University of Illinois, Urbana.*

Crossbred Simmental cows (n=108) nursing heifer calves from two farms (36 pairs grazing mixed cool-season grasses and 72 pairs grazing fescue pasture) were stratified by weight and randomly assigned to three treatments. Treatments were no creep (NC), 14% CP creep (NPC) and 18% CP creep (HPC). Both creep feeds contained Bovatec and were offered *ad libitum*. Objectives were to evaluate the effect of protein level and creep feeding on heifer calf and dam performance, as well as subsequent calf milk production. Initial and final weights for the 84 d creep feeding period were recorded after 16 hour shrink. Calf hip height, cow weight and body condition score (BCS) were measured at trial initiation and termination. Heifer milk production estimates are means of three weigh-suckle-weigh measurements at days 52, 108 and 164 of lactation. Statistical analysis utilized pen means for cow and calf performance data, individual animal for calving and milk production data. Treatment by farm interaction was not significant ( $P > 0.05$ ). Creep-fed (CF) heifers were heavier at weaning ( $P < 0.01$ ) (228.0 kg) than NC (203.1 kg), with no differences between NPC and HPC. High protein creep fed heifers tended ( $P < 0.10$ ) to gain faster (1.21 kg) than NPC (1.12 kg). Calf hip height and cow gains were not different. Cows nursing CF calves had increased ( $P < 0.05$ ) BCS (4.88) at weaning compared to cows nursing NC calves (4.46). No differences in birth date, birth weight, calving ease, weaning weight or weaning hip height resulted from creep feeding dams as calves. Heifers not receiving creep feed as calves were heavier milking (7.09 kg/d) as cows than creep fed (5.80 kg/d) heifers. In this study, additional CP in creep diets was not beneficial in increasing calf weaning weight, cow performance or preventing milk production suppression in creep fed beef heifers.

**Key Words:** Creep Feeding, Milk Production, Heifers

**336 Supplementation of lactating two-year-old cows consuming meadow hay to meet metabolizable protein requirements versus degradable intake protein requirements.** H. H. Patterson\*, A. M. Hopkin, D. C. Adams, and T. J. Klopfenstein, *University of Nebraska, Lincoln.*

The objective of the experiment was to determine the effects of supplementing two-year-old lactating cows to meet metabolizable protein (MP) versus degradable intake protein (DIP) requirements on cow production traits. Eighteen cows (394 7 kg), with *ad-libitum* access to meadow hay (8.6% CP, 80% NDF, OM basis), were assigned to one of two treatments: 1) suppl. to meet MP requirements (MPR) or 2) suppl. to meet DIP requirements (DIPR). Supplements were individually fed three times weekly from approximately 16 to 65 d after parturition and supplied similar amounts of DIP and TDN. Cows and calves were weighed and cows assigned a body condition score (BCS) on two consecutive days at the beginning and end of the experiment. Heifers were bled weekly and luteal activity determined by plasma progesterone concentrations greater than 1 ng/ml. Milk production was measured by the weigh-suckle-weigh procedure at approximately 29 and 56 d after parturition. Intake was measured using a marker method at approximately 41 d after parturition. No cows expressed luteal activity during the experiment. Hay intake and milk production were similar between treatments ( $P > .50$ ). Organic matter hay intake averaged 9.2 kg/d (2.4% of BW), and milk production averaged 7.3 and 4.8 kg/d at 29 and 56 d after parturition, respectively. Cow BCS change (0.004 and -0.001 BCS/d) and calf ADG (0.62 and 0.59 kg/d) were similar ( $P > .20$ ) between MPR and DIPR, respectively. Cow ADG was higher ( $P = .02$ ) for MPR (0.41 kg/d) than DIPR cows (0.14 kg/d). Because of higher than predicted milk production, MP was estimated to be deficient in the MPR (-66 g/d) and DIPR (-181 g/d) cows at 29 d after parturition. At 56 d after parturition, MP balance was positive for MPR cows (58 g/d) and negative for DIPR cows (-57 g/d). Supplementing lactating cows to meet MP requirements increased postpartum weight change, but it did not affect BCS or milk production.

**Key Words:** Cows, Lactating, Metabolizable Protein

**337 Increasing dietary protein to metabolizable energy ratios on feed efficiency, structural growth, and body condition score of prepubertal Holstein heifers.** M.T. Gabler\* and A.J. Heinrichs, *Pennsylvania State University*.

Sixty Holstein heifers, 124.51.1 d of age and 124.92.5 kg of BW, were used to evaluate dietary protein to metabolizable energy ratio's (g CP: Mcal ME) influence on feed efficiency, structural growth, and body condition. Diets containing a specific CP: ME ratio were assigned to heifers in a complete randomized block design, with treatment period lasting 20 wk. The diet's CP: ME ratios were 48:1, 59:1, 68:1, and 77:1 g of crude protein (CP) per Mcal of metabolizable energy (ME). Diets contained corn silage and grass hay as forage sources with a protein pellet and supplemental soybean meal as the protein sources, 60:40 forage: concentrate ratio. The CP: ME ratios were altered by adjusting the concentration of CP with similar amounts of ME across all diets. Heifers were individually fed once daily. Body weight was recorded weekly on two consecutive days and used to adjust dry matter intake to allow approximately 0.8 kg/d gain. Average daily gain (kg/d) was not different ( $p = 0.27$ ) for the treatment diets, 0.74, 0.81, 0.81, 0.77, low to highest CP: ME ratio respectively. Dry matter intake (kg/d) was not different ( $p = 0.33$ ) for the treatment diets, 3.25, 3.42, 3.47, and 3.35, low to highest CP: ME ratio respectively. Feed efficiency tended to improve linearly ( $p = 0.08$ ) with increasing CP: ME ratios, 4.76, 4.42, 4.35, and 4.33 respectively. The increased CP: ME ratios were accompanied by increasing levels ( $p = 0.01$ ) of blood urea nitrogen (mg/dl), 9.03, 11.30, 13.06, and 14.90, respectively. The increased CP: ME ratios approached a linear increase ( $p = 0.10$ ) in wither and hip height growth. Changes in hip width, heart girth, and body condition score were not different with increasing CP: ME ratios. Feeding CP: ME ratios above NRC recommendations (56:1 g CP/Mcal ME) to heifers 16 to 39 wk of age increased circulating levels of blood urea nitrogen, but did not result in changes in feed efficiency or structural growth.

**Key Words:** Heifers, Growth, Protein to Energy Ratios

**338 Difference in response of Holstein and Brown Swiss cows to diets containing fish oil, extruded soybeans, or their combination.** L. A. Whitlock\*, D. J. Schingoethe, A. R. Hippen, R. J. Baer, N. Ramaswamy, and K. M. Kasperon, *MN-SD Dairy Foods Research Center, South Dakota State University, Brookings*.

Milk production and composition data were evaluated for four multiparous Holstein and four multiparous Brown Swiss cows which were randomly assigned to four treatments in a replicated 4 x 4 Latin square design with 4 wk periods. The four treatments consisted of a control diet (C) with a 50:50 ratio of forage to concentrate, a C diet with 2% (DM basis) added fat from menhaden fish oil (FO), a C diet with 2% added fat from extruded soybeans (ESB), and a C diet with 1% added fat from menhaden fish oil and 1% added fat from extruded soybeans (FOESB). Milk production from Holsteins and Brown Swiss averaged 36.9 and 30.5 kg/d, respectively, and milk fat averaged 2.77 and 3.29%, respectively, across the four diets. Milk fat (3.31, 2.64, 3.14, and 3.04 %, for cows fed the C, FO, ESB, and FOESB diets, respectively) was lower ( $P < 0.05$ ) when fed the FO diet compared to the other three diets. No breed differences in fatty acid composition of milk due to diet were observed for chain length, degree of saturation, and n-3 composition. However, the two breeds responded differently to the diets in content of cis-9, trans-11 conjugated linoleic acid (CLA), ( $P < 0.08$ ), and trans-vaccenic acid (TVA), ( $P < 0.11$ ). The CLA content of Holstein milk averaged 0.51, 1.78, 1.26, and 2.31 g/100 g fatty acids, respectively, when fed the C, FO, ESB, and FOESB diets, while Brown Swiss milk averaged 0.72, 2.22, 1.18, and 1.62. Similarly, TVA content of Holstein milk averaged 0.78, 3.09, 2.14, and 4.61 g/100 g fatty acids, and averaged 1.29, 5.00, 2.25, and 3.22 in Brown Swiss milk when fed the C, FO, ESB, and FOESB diets. The CLA and TVA content in Brown Swiss milk was generally higher when fed the C and FO diets, but lower when fed the ESB and FOESB diets.

**Key Words:** Conjugated Linoleic Acid, Milk, Breed

**339 Effect of BMR corn silage on lactation performance of primiparous and multiparous lactating dairy cows.** T. D. Nennich\*<sup>1</sup>, J. G. Linn<sup>1</sup>, and H. G. Jung<sup>1,2</sup>, <sup>1</sup>*University of Minnesota, St. Paul*, <sup>2</sup>*USDA-ARS, St. Paul*.

Brown midrib (BMR) corn silage grown in 1999 was compared to a mixed blend of high grain corn silage grown in 1998 in an on-farm study

with early and mid-lactation primiparous and multiparous lactating Holstein dairy cows. The study was a switchback design where cows were divided into four pens according to stage of lactation (early lactation 93±18 days in milk (DIM) or mid lactation 151±14 DIM) and parity. Early and mid-lactation pens contained 94±10 and 127±8 cows, respectively. Cows moved in and out of pens throughout the study according to standard operating procedures for the dairy based on number of cows per pen and cow DIM. Cows were group fed one of two dietary treatments containing either BMR corn silage or the 1998 corn silage (CON) for 14 d periods. The last 7 d of each period was used as the data collection period. Diets were fed for four periods in a double switchback design. The diets were formulated for 24% forage NDF, contained 46% or 58% corn silage (DM basis) in the first two periods and last two periods, respectively, and were formulated to be both isocaloric and isonitrogenous. Milk production and dry matter intake were measured by pen. Milk composition was analyzed by pen for percent fat and crude protein. There was not a diet by parity or a diet by stage of lactation interaction ( $P > .05$ ). Within parity or stage of lactation, cows fed the BMR corn silage diet produced more milk ( $P < .02$ ) than cows fed the control corn silage diet (Table 1). Overall, BMR increased milk production by 2.5 kg per day. DMI intake was not different ( $P > .02$ ) between diets, but a trend was observed towards increased intakes with BMR silage and as stage of lactation increased.

Item	Parity		Stage of Lactation	
	Primiparous	Multiparous	Early	Late
Milk, kg/d				
CON	34.5 <sup>b</sup>	42.4 <sup>b</sup>	37.9 <sup>b</sup>	39.0 <sup>b</sup>
BMR	36.9 <sup>a</sup>	45.0 <sup>a</sup>	40.3 <sup>a</sup>	41.6 <sup>a</sup>
DMI, kg/d				
CON	21.2	25.1	22.4	24.0
BMR	21.8	25.9	22.9	24.8

<sup>a,b</sup>Mean milk production within parity or stage of lactation not sharing a common superscript differ ( $P < .02$ ).

**Key Words:** Brown Midrib, Corn Silage, Milk Production

**340 Supplementing whole soybeans prepartum increases first service conception rate in postpartum suckled beef cows.** K. K. Graham\*<sup>1</sup>, J. F. Bader<sup>1</sup>, D. J. Patterson<sup>1</sup>, M. S. Kerley<sup>1</sup>, and C. N. Zumbrennen<sup>2</sup>, <sup>1</sup>*University of Missouri, Columbia*, <sup>2</sup>*Sullivan County Outreach and Extension Center, Milan, MO*.

Multiparous beef cows were used in two experiments to determine if feeding whole soybeans prepartum would improve cyclicity rate, estrus response during the synchronized period, first service conception rate, and pregnancy rate at the end of the breeding period. Two supplements consisting of 1.6 kg of whole soybeans·animal<sup>-1</sup>·d<sup>-1</sup> (WSB) or 1.4 kg of corn gluten feed and .45 kg of soybean meal·animal<sup>-1</sup>·d<sup>-1</sup> (CGSBM) were fed. Supplementation was initiated 45d before calving, at calving, or 30 d before breeding for Experiment 1, and 30 d before calving in Experiment 2. Cows in Experiment 1 were synchronized using two injections of prostaglandin F<sub>2α</sub> (PG) 14 d apart. All cows were exposed for a 45-d natural service breeding period. Pregnancy was determined 90 d after the breeding period. First service conception rates were higher ( $P \leq .05$ ) for the WSB supplement (75%) compared to the CGSBM supplement (62.5%;  $P \leq .05$ ) only when supplementation was initiated prior to calving. No differences ( $P \geq .05$ ) between the two supplements were seen in final pregnancy rates. Cows in Experiment 2 were synchronized using a modified MGA-GnRH-PG protocol. Serum progesterone was measured from two blood samples taken 10 days before MGA feeding was initiated to determine cyclicity. Cows were observed for estrus for 144 h after d 6 and artificially inseminated 12 h after the first detection of estrus. All cows were inseminated using semen from the same bull by one technician. No differences ( $P \geq .05$ ) in average body weights, body condition scores or cyclicity was seen between treatments. First service conception rates were greater ( $P \leq .05$ ) for the cows fed WSB (85.7%) than for cows fed the CGSBM supplement (62.8%). Synchronized pregnancy rates were also increased ( $P \leq .05$ ) when animals were supplemented with WSB (76.6%) vs. CGSBM (57.4%). Feeding whole soybeans to mature beef cows prepartum increased first service conception rates and numerically increased pregnancy rates.

**Key Words:** Soybeans, Conception Rate, Beef Cows

**341 Effects of restricting time of access to large round bales of hay on feed waste and cow performance.** A.J. Miller\*, D.B. Faulkner, T.C. Cunningham, and J.M. Dahlquist, *University of Illinois*.

Seventy-two Simmental cows (567.2 ± 16.5 kg) in the third trimester of gestation were allotted to one of four treatments: Ad libitum hay (no time restriction) or access restricted to 9, 6, or 3 hours/day, to determine the effects of time restricted access to large round bales on cow performance and hay disappearance. Cows were blocked by weight and assigned to 12 pens resulting in 6 cows per pen and 3 pens per treatment. Each pen had adequate bunk space for 7 head, and time was limited by gating off feeders. Hay fed contained 17.8% CP, 45.7% NDF, 35.7% ADF, and had a Relative Feed Value of 125. The trial was conducted from September 13 to December 9 (87 days). Cows allowed ad libitum access gained more weight (94.2 kg) than the 3-hour treatment (53.7 kg, P=.003) or the 6-hour treatment (72.9 kg, P=.06). The 9-hour and 6-hour treatments also had higher weight gains than the 3-hour treatment (P=.009, P=.08). Cows on the 3-hour treatment gained less body condition (.05) than 6-hour cows (.46, P=.07), 9-hour cows (.69, P=.01), and ad libitum cows (.77, P=.005). Hay disappearance was significantly lower (P<.001) for the 3-hour treatment (8.2 kg/head/day) than the 6-hour (11.3 kg/head/day), 9-h (13.5 kg/head/day), or ad libitum (15.8 kg/head/day) treatments. The 6-hour treatment was lower (P<.01) than the 9-hour or ad libitum treatments and the 9-hour treatment was lower (P<.01) than ad libitum. Restricting time of access to large round bales of high quality hay will reduce hay disappearance while maintaining acceptable levels of cow performance.

**Key Words:** Cows, Hay, Limit-Feeding

**342 Relationship between aging and nutritional controlled growth rate on heat production of ewe lambs.** H. C. Freetly\*, J. A. Nienaber, and T. M. Brown-Brandl, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE*.

The objective of this study was to determine how nutritionally reducing growth rate alters the relationship between specific activity of heat production and aging. Fasting heat production of 12 Dorset ewe lambs at 114 ± 2 d of age was determined and ewes were assigned to treatments. Treatments consisted of two different feeding levels. The **HIGH** treatment was offered 4.5% of their weekly BW and the **LOW** treatment was offered 2.5% of their weekly BW. Each treatment consisted of six animals and animals remained within treatment for the remainder of the study. Calorimetry measurements were repeated every 6 wk. Treatments differed in both the linear and quadratic term for fasted BW on age (P < 0.001). The rate of BW gain decreased as ewes aged in the HIGH treatment and the rate of BW gain increased as ewes aged in the LOW treatment. The HP:BW ratio decreased in the HIGH treatment as ewes aged and was described by a previously reported prediction equation but the ratio in the LOW treatment was not described by this same equation. Fitting the data with treatment specific decay functions for HP:BW on age fit the data better than the pooled function. The HP:BW ratio decreased rapidly in the LOW treatment following feed restriction but remained elevated compared with the HIGH treatment as animals aged. After excluding the initial measurements in the LOW treatment when ewes were on the HIGH level of feed the HP:BW ratio was best described by a linear decrease. In conclusion, this study suggests that a model taking into account proportion of mature body size is a reasonable predictor for heat production across breeds of sheep growing in nutritionally adequate environments; however, it cannot be extended to sheep that are a lower proportion of their mature BW due to nutritional restriction.

**Key Words:** Sheep, Growth, Energy

**343 Effects of rumen undegradable protein digestibility and supplemental methionine on production parameters of holstein cows in early lactation.** S. Noftsker\* and N. St-Pierre, *The Ohio State University*.

Agriculture is receiving increased environmental scrutiny for its N and P contribution to the environment. It is clear that improving N efficiency in the production of milk will gain economic value in the future. NRC recommendations for RUP do not consider the differences in RUP digestibility and amino acid balance. Sixty Holstein cows were used to investigate the effects of RUP digestibility and amino acid balance.

Treatments were: 1)high CP (18.3%) low RUP digestibility (control), 2)high CP, high RUP digestibility (Hi), 3)low CP (16.9%), high RUP digestibility (Lo), and 4)low CP, high RUP digestibility with supplemental methionine (Lo-Met). Treatment affected DMI, with high digestibility RUP increasing intake over control. High digestibility RUP also increased milk, fat and protein yields. Milk urea nitrogen was decreased by decreasing the CP in the diet.

	control	Hi	Lo	Lo-Met	SEM	P-value		
							treatment	parity
DMI(kg/d)	21.7	23.3	23.2	23.6	.49	.04	.001	
Milk (kg/d)	40.8	46.2	42.9	46.6	.72	.001	.001	
fat (kg/d)	1.39	1.67	1.57	1.71	.029	.001	.001	
protein (kg/d)	1.20	1.38	1.28	1.44	.024	.001	.001	
fat (%)	3.42	3.64	3.66	3.73	.053	.004	.05	
Protein (%)	2.95	2.98	2.99	3.09	.027	.002	.037	
MUN (mg/dL)	16.82	17.28	14.3	13.47	.3	.001	.2	

**Key Words:** Rumen Undegradable Protein, Methionine, Milk Production

**344 Leucine and valine, but not isoleucine, are limiting in soybean hull-based diets for growing cattle.** C. A. Loest\*, E. C. Titgemeyer, B. D. Lambert, and A. M. Trater, *Kansas State University, Manhattan*.

Five ruminally cannulated Holstein steers (176 kg) were used in a 5 x 5 Latin square to evaluate the effects of branched-chain amino acids (BCAA) on N retention and plasma amino acid concentrations of steers. Steers were limit-fed (3.0 kg DM daily) twice daily diets high in rumen degradable protein (72% soybean hulls, 19% alfalfa, 5% molasses, 4% minerals and vitamins). Acetate (400 g/d) was continuously infused into the rumen. Treatments were continuous abomasal infusions of 1) 115 g/d of a mixture of 10 essential amino acids (10AA), 2) 10AA with Leu removed (-LEU), 3) 10AA with Ile removed (-ILE), 4) 10AA with Val removed (-VAL), and 5) 10AA with all three BCAA removed (-BCAA). Periods were 7 d with 3 d for adaptation to treatments and 4 d for total fecal and urinary collections for N balance. Blood samples were collected 5 h post-feeding on d 7. Retained N decreased (P < 0.06) in response to removal of Leu, Val, or all three BCAA. Plasma Leu concentrations decreased (P < 0.05) in response to removal of Leu and all three BCAA; plasma Ile concentrations decreased (P < 0.05) in response to removal of Ile and all three BCAA, but increased (P < 0.05) in response to removal of Leu; and plasma Val concentrations decreased (P < 0.05) in response to removal of Val and all three BCAA, but increased (P < 0.05) in response to removal of Leu. Responses in N balance and plasma amino acid concentrations of growing cattle limit-fed soybean hull-based diets demonstrate limitations in the basal supply of Leu and Val, but not Ile.

Item	10AA	-LEU	-ILE	-VAL	-BCAA	SEM
N retention, g/d	25.7	23.1 <sup>b</sup>	24.8	22.4 <sup>a</sup>	21.2 <sup>a</sup>	0.79
Plasma Leu, μM	200	60 <sup>a</sup>	190	217	60 <sup>a</sup>	7.8
Plasma Ile, μM	148	296 <sup>a</sup>	55 <sup>a</sup>	154	88 <sup>a</sup>	15
Plasma Val, μM	298	530 <sup>a</sup>	289	123 <sup>a</sup>	162 <sup>a</sup>	21

<sup>a</sup> Different from 10AA (P < 0.05). <sup>b</sup> Different from 10AA (P < 0.06).

**Key Words:** Leucine, Valine, Cattle

**345 Impact of glycine supply on utilization of methionine and cysteine by cattle.** B. D. Lambert\*, E. C. Titgemeyer, and C. A. Loest, *Kansas State University, Manhattan*.

Because Gly is a precursor for Ser synthesis and is involved in metabolism of the one-carbon pool, we hypothesized that absorbable Gly supply might impact sulfur amino acid (AA) use in cattle. In Exp. 1, four ruminally cannulated Holstein steers (132 kg) were used in a 4 x 4 Latin square to evaluate effects of Gly supply on Met use. Steers were fed 2.2 kg DM/d of a diet containing 83% soybean hulls and 8% wheat straw. Ruminant infusions of 180 g/d acetate, 180 g/d propionate, 45 g/d butyrate, and abomasal infusion of 300 g/d dextrose provided energy. An AA mixture (352 g/d) limiting in Met (2 g/d) was infused abomasally to ensure that nonsulfur AA did not limit growth. Steers received a daily supplement of 10 mg folate, 10 mg vitamin B-6, and 100 μg vitamin B-12 because they serve as cofactors in Met metabolism. Periods were 7 d with 3 d adaptations and 4 d of excreta collection. Treatments, infused abomasally, were 1) control, 2) 3 g/d added L-Met,

3) 50 g/d Gly, and 4) 3 g/d L-Met + 50 g/d Gly. Retained N (34.4, 40.9, 33.6, and 49.5 g/d for control, Met, Gly, and Met+Gly, respectively) increased ( $P < 0.05$ ) in response to Met. A numerically ( $P = 0.23$ ) greater N retention response to Met when Gly was supplemented suggests that Gly supply impacted Met use. Basal conditions for Exp. 2 were similar to Exp.1 except the basal AA mixture was decreased to 260 g/d. Treatments, infused abomasally, were: 1) control, 2) 2.4 g/d L-Cys, 3) 40 g/d Gly, and 4) 2.4 g/d L-Cys + 40 g/d Gly. Retained N (21.7, 21.8, 18.4, and 24.8 g/d for control, Cys, Gly, and Cys+Gly, respectively) was not affected by Cys in the absence of Gly, but was increased by Cys when Gly was supplemented (Cys  $\times$  Gly interaction,  $P = 0.01$ ). This is in contrast to previous results from our laboratory where Cys did not alter N retention in the presence of Gly, although B-vitamins were not supplemented in previous studies. Thus, B-vitamin status may impact sparing of Met by Cys. Supplemental Gly numerically improved Met use and increased retained N when given with Cys.

**Key Words:** Cattle, Methionine, Glycine

**346 Effects of bloodmeal and arginine-HCl on serum hormone, plasma amino acid, and nitrogen retention in growing steers.** J. W. Lehmkuhler\*, C.D. Morrison, A. Moore, D.H. Keisler, and M. S. Kerley, *University of Missouri, Columbia.*

Twelve crossbred steers (initial BW=227kg) were used in a replicated 3X3 Latin square design to determine the effect of a 16% CP soybean meal based diet (CON), 16% CP bloodmeal diet (BM), or 12% CP soybean meal diet+arginine-HCl (protected in a wax matrix) (ARG) on serum hormone, plasma amino acid (PAA), and protein retention levels. Steers were housed in a thermoneutral chamber with continuous lighting and weighed prior to the initiation of each period to adjust DM intake to 2% of BW. The study design consisted of a 7d adaptation period followed by 4d total fecal and urine collection. Jugular catheters were inserted into the steers on d 12 and blood was collected every 15 min for 8 h on d 13. ADG did not differ among treatments and averaged 0.74 kg/d. Nitrogen intake was lower ( $P < .05$ ) for ARG, while similar for SBM and BM. Fecal, urinary, and total nitrogen excretion was similar across treatments. Steers receiving BM and CON had similar nitrogen retention (32.2 vs. 34.9%) which was greater ( $P < .05$ ) than with the ARG diet (22.1%). Plasma urea was greater ( $P < .05$ ) in CON steers compared to other treatments. Plasma Thr, Lys, and His were increased ( $P < .05$ ) by feeding BM in comparison with CON and ARG. Circulating levels of Gln, Met, Trp, Orn, and Arg did not differ among treatments. Serum insulin levels were greater for BM ( $P < .1$ ) as compared with the other diets. Likewise, total serum T4 was elevated ( $P = .1$ ) with the inclusion of BM while both CON and BM tended to have higher circulating levels of IGF-1 ( $P = .13$ ) in comparison to ARG.

## UNDERGRADUATE STUDENT COMPETITIVE RESEARCH PAPERS

**348 Effects of added phytase in swine diets on performance, body composition, and longissimus dorsi quality traits.** R. M. Rienstra\*<sup>1</sup>, T. E. Socha<sup>1</sup>, J. E. Tilton<sup>1</sup>, and R. Fisher<sup>2</sup>, <sup>1</sup>North Dakota State University, Fargo, <sup>2</sup>Vigortone Ag Products, Cedar Rapids, IA.

Reduction of phosphorus intake without altering performance is a major goal in swine feeding programs. The effect of adding phytase and lowering P intake was tested. In two treatments, 128 pigs were stratified by initial weight and assigned randomly to 8 pens in a randomized complete block design (RCBD). Pigs were fed either a control diet or phytase-added diet. Dietary phosphorus intake was reduced in the phytase treatment by 58% in pigs fed to 59 kg (0.21%) and by 26% from 59 to 114 kg (0.08%). Pigs were removed from the test when the pen average exceeded 114 kg or when a final weight of 125 kg was reached. Feed intake was recorded throughout the experiment and real-time ultrasound data was collected prior to slaughter. Loin quality traits of color, marbling, firmness, ultimate pH and Hunter L values were evaluated 24 h post mortem. NPPC adjustment factors were used to determine adjusted composition values at 114 kg. Analysis of growth and feed intake data was done using a RCBD method. Carcass traits were analyzed using treatment as the independent variable. Daily feed intake (2.55 vs 2.51 kg/d), feed efficiency (361 vs 362g/kg of feed) and overall average daily gain (0.92 vs 0.91 kg) were not different ( $P > 0.10$ ) between treatments. Scan data from pigs prior to slaughter indicated adjusted backfat (20.3 vs 20.6 mm) and adjusted percent fat-free lean (51.58 vs

52.10) were also not different ( $P > 0.10$ ) between treatments. However, adjusted loin eye area (40.51 vs 42.51 cm<sup>2</sup>) was greater ( $P < 0.01$ ) in the phytase treatment. Intramuscular fat (2.21 vs 2.04%) determined by ether extraction was not different ( $P > 0.10$ ) between treatments, but marbling (2.13 vs 1.89) and drip loss (3.81 vs 3.24%) were lower ( $P < 0.05$ ) in the phytase treatment. Color, firmness, pH and Hunter L scores did not differ ( $P > 0.10$ ) between treatments. Addition of phytase did affect marbling, drip loss, and adjusted loin eye area but did not affect other carcass characteristics. Phytase may increase carcass value by increasing loin eye area and reducing cooler shrink.

**Key Words:** Ruminant, Endocrine, Protein

**347 Effects of forage type and concentrated separator by-product (CSB) on intake and digestion in beef steers.** J. E. Leonard\*, M. L. Bauer, G. P. Lardy, V. I. Burke, T. C. Gilbery, and J. S. Caton, *North Dakota State University, Fargo.*

Four ruminally and duodenally cannulated beef steers (444 40 kg) were used in a 4 x 4 Latin square to evaluate effects of forage type and CSB addition on intake and digestion. Treatments were arranged in a 2 x 2 factorial. Factors were forage types (alfalfa and cornstover) and CSB additions. Concentrated separator byproduct was mixed with forage and offered at 0 or 10% of the diet DM. Experimental periods were 21 d and steers were allowed 12 d adaptation before collections began. Main effects of alfalfa and CSB will be discussed unless there were forage x CSB interactions ( $P < 0.10$ ). Intakes (g/kg BW) of DM (21.4 vs 8.1) and OM (18.9 vs 7.3) were higher ( $P < 0.01$ ) for steers fed alfalfa compared with those fed cornstover. Steers fed CSB consumed more ( $P < 0.01$ ) DM than controls (16.4 vs. 13.2 g/kg BW). In addition, OM intake tended ( $P = 0.15$ ) to be influenced by CSB addition. As expected, total tract digestions of DM, OM, and ADF were greater ( $P < 0.10$ ) in steers fed alfalfa compared with cornstover (63.2 vs 54.8 % for OM digestion). No effects ( $P > 0.10$ ) of CSB on digestion coefficients were noted. In situ rate of NDF digestion was higher ( $P = 0.08$ ) in alfalfa compared with cornstover (11.3 vs 3.8 %/h) and lower in control vs CSB (6.7 vs 8.4 %/h). Interactive means for total tract CP digestion within cornstover were -26.4%, for control, and 29.0%, for 10% CSB. Interactive means differed ( $P < 0.10$ ) among treatment, for in situ rate of CP disappearance, and were 9.8, 10.8, 0.8, and 7.6 0.4 %/h for alfalfa, alfalfa with CSB, cornstover, and cornstover with CSB, respectively. Within alfalfa and cornstover treatment, CSB fed steers had higher in situ CP Fraction A (49.1 and 71.7 vs 36.6 and 46.5%;  $P < 0.10$ ) and lower Fraction B (44.5 and 17.1 vs 51.9 and 40.9%;  $P < 0.10$ ). Data suggest that feeding CSB will increase intake, and rates of digestion. Effects of CSB are more pronounced in mature forage based diets.

**Key Words:** Forage, Intake, Concentrated Separator By-Product

52.10) were also not different ( $P > 0.10$ ) between treatments. However, adjusted loin eye area (40.51 vs 42.51 cm<sup>2</sup>) was greater ( $P < 0.01$ ) in the phytase treatment. Intramuscular fat (2.21 vs 2.04%) determined by ether extraction was not different ( $P > 0.10$ ) between treatments, but marbling (2.13 vs 1.89) and drip loss (3.81 vs 3.24%) were lower ( $P < 0.05$ ) in the phytase treatment. Color, firmness, pH and Hunter L scores did not differ ( $P > 0.10$ ) between treatments. Addition of phytase did affect marbling, drip loss, and adjusted loin eye area but did not affect other carcass characteristics. Phytase may increase carcass value by increasing loin eye area and reducing cooler shrink.

**Key Words:** Swine, Phytase, Carcass quality

**349 Comparative feeding value of commercially prepared market lamb feeds.** R.S. Reid\*<sup>1</sup>, G.A. Younglove<sup>1</sup>, D.A. Sanchez<sup>2</sup>, S. Nash<sup>3</sup>, and S. Harrison<sup>4</sup>, <sup>1</sup>Chadron State College, <sup>2</sup>University of Wyoming Uinta County Extension, <sup>3</sup>University of Idaho Bingham County Extension, <sup>4</sup>University of Idaho Caribou County Extension.

Forty-eight mixed breed market lambs from four producers were used in a completely randomized block design with two repetitions to evaluate the effect of commercially prepared lamb diets on average daily gain (ADG) and carcass quality. Lambs were randomly allotted by weight to one of five commercially prepared diets or a control diet (rolled corn and

soybean meal) such that each producer was represented in each pen. Diets were fed for 79 d according to directions on the feed label. Two lambs were removed from the study due to reoccurring rectal prolapse. Average daily gain was similar between the five commercially prepared diets (0.53 - 0.59 lb/d); however, lambs on the control diet appeared to have lower ADG (0.41 lb/d). Percent lean retail product (56.41 - 57.30%) and percent product of live weight (28.12 - 28.65%) were similar between all diets. Although all lambs graded choice according to USDA graders at ConAgra, 36 of the lambs were discounted due to insufficient fat cover.

**Key Words:** Carcass quality, Average daily gain, Commercial lamb diets

**350 Identification and mapping of pig sequence tagged-sites.** C. P. Wilkinson\*, P. J. Venta, N. E. Raney, C. R. Farber, C. W. Ernst, and C. W. Ernst, *Michigan State University, East Lansing.*

Comparative mapping allows the transfer of information from the human genome map to other species where resources for mapping are much more limited. The objective of an ongoing project in our laboratory is to increase the density of the pig comparative map through the development and mapping of pig sequence tagged-sites (STSs). In the current study, pig STSs were developed for argininosuccinate lyase (ASL), mast cell chymase 1 (CMA1), leukemia-associated phosphoprotein p18 (LAP18), and ribosomal protein S19 (RPS19). PCR primers utilized to amplify these genes in the pig were designed either as part of the universal mammalian sequence-tagged sites (UM-STS) project (Venta et al., 1996) or by using heterologous sequences published in the GenBank database. The identity of each STS was confirmed by sequencing the PCR products using an ABI 373 automated DNA sequencer. Radiation hybrid mapping of the STS for CMA1 was carried out using the INRA-University of Minnesota porcine Radiation Hybrid (IMpRH) panel. Significant linkage was observed between CMA1 and four markers on the q arm of pig chromosome 7 (SSC7). These markers were S0334, TCRA, SW255, and SWR1806 with LOD scores of 11.5, 9.08, 6.81, and 5.08, respectively. The comparative location for this region of SSC7 in the human is chromosome (HSA) 14q11.2-q13 and q22-qter. Our results are consistent with the human map location of CMA1 to HSA14q11.2. Physical, RH, and genetic linkage mapping of the remaining markers, as well as the identification of additional STSs is in progress. Results from this study will help to further improve the pig and human comparative map.

**Key Words:** pig, comparative mapping, sequence tagged-sites

**351 Effects of a moisture control system on energy and nitrogen digestibility of pelleted feeds for growing pigs.** J. A. Wilson\*<sup>1</sup>, L. J. Johnston<sup>1</sup>, and D. G. Greer<sup>2</sup>, <sup>1</sup>*University of Minnesota, Morris*, <sup>2</sup>*AgriChem, Inc., Ham Lake, MN.*

The Grain-Prep Auto Delivery System<sup>®</sup> (GP) has improved pellet durability and moisture control in complete poultry feeds. Improved moisture control of pelleted swine diets may improve diet digestibility. We conducted a nutrient balance study to evaluate the effects of this system on energy and nitrogen digestibility in swine grower diets. Twenty-one, barrows weighing 9.9 .45 kg, were blocked by litter and randomly assigned to one of three corn-soybean meal based dietary treatments: 10% moisture meal (10M), 10% moisture pellet (10P), or 15% moisture pellet plus Grain-Prep<sup>®</sup> surfactant (15P). Analyzed moisture content of diets at manufacturing was 9.5%, 10.3%, and 15.3% for 10M, 10P, and 15P, respectively. Pellet durability measured by the standard KSU Pellet Durability Index (PDI) increased in the 15P treatment (83.8%) compared to the 10P treatment (68.5%). Pigs were housed in individual metabolism crates for 10 d and fed their respective experimental diets at a rate of 2% of body weight daily offered in two equal meals. All urine and feces were collected on d 6 to 10. Apparent nitrogen and energy balance were determined by Kjeldahl and bomb calorimetry, respectively. There were no differences ( $P > .2$ ) in ADFI, ADG, or energy and nitrogen intake. Likewise, gain to feed ratio was not different ( $P > .6$ ; SE = .06) among pigs fed 10M (.93), 10P (1.00), and 15P (.98). Energy retention for pigs fed 15P (86.1%) was greater ( $P < .10$ ) than that of pigs fed 10P (83.2%) but not different ( $P > .4$ ) than pigs fed 10M (84.8%). Nitrogen retention (%) was not influenced ( $P > .2$ ) by processing conditions (10M, 65.5; 10P, 62.2; 15P, 62.7; SE = 1.73). Energy and nitrogen retention were unaffected by GP compared to meal feed. These results suggest that addition of moisture and Grain-Prep<sup>®</sup> surfactant to

pelleted corn-soybean meal diets improved energy retention of growing pigs and appeared to improve pellet durability.

**Key Words:** Pelleting, Digestibility, Swine

**352 Energy supplementation of nursing beef calves on native range in southeastern North Dakota.** T. D. Klein\*, A. M. Encinias, H. B. Encinias, M. L. Bauer, J. S. Caton, and G. P. Lardy, *North Dakota State University, Fargo.*

Energy has been implicated as the first limiting nutrient in nursing beef calves in southeastern North Dakota. Thirty nursing beef calves (20 heifers, 10 steers; 216 6 kg BW) were stratified by BW, milk intake, and age of dam to examine the effect of 60-d calf energy supplementation on calf and dam performance. Calves were assigned to one of three treatments: non-supplemented control (NS), low level of supplement (LS; 0.75 kg DM/d), or high level of supplement (HS; 1.5 kg DM/d). The supplement consisted (DM basis) of 47.1% soybean hulls, 46.5% wheat middlings, 5% molasses, 1.2% limestone, and 0.2% dicalcium phosphate. Cow and calf gain was measured using 3-d consecutive averages every 28 d. Dam body condition score and calf milk intake was estimated monthly. Milk intake was estimated using an 8-h weigh-suckle-weigh. Calf forage intake was estimated with total fecal collections using 4 NS steers, 3 LS steers, and 3 HS steers. Additionally, five ruminally and duodenally NS cannulated calves were used to determine site of digestion, microbial flow, and microbial efficiency in nursing beef calves. Cow BW change ( $P = 0.30$ ) and BCS change ( $P = 0.95$ ) was not influenced by supplementation to calves. Treatment had no effect on calf forage ( $P = 0.42$ ) or milk ( $P = 0.59$ ) intake, or daily gain ( $P = 0.57$ ). Sources of nursing beef calf duodenal N were 32% microbial, 26% milk, and 42% forage N. Energy did not appear to limit calf performance.

Table 1. Cannulated nursing calf data.

Item	Mean	SD
		g/d
Total OM intake	2628	864
Forage OM intake	2302	753
Milk OM intake	326	133
Total N intake	75.8	19.0
Forage N intake	59.6	13.6
Milk N intake	16.2	6.6
Duodenal N flow	61.2	14.1
Microbial N flow	19.4	5.5
Estimated milk N flow	16.2	6.6
Estimated non-microbial non-milk N flow	25.6	11.8

<sup>1</sup>g microbial N/kg OM truly fermented

**Key Words:** Nursing Calf, Native Range, Microbial Efficiency

**353 Conjugated linoleic acid and body fat reduction in mice.** K.R. Nollette\*<sup>1</sup> and J.L. Miner<sup>1</sup>, <sup>1</sup>*University of Nebraska.*

Consumption of a conjugated linoleic acid (CLA) isomer mixture by rodents causes rapid loss of body fat. We have observed that this effect is associated with apoptosis in white adipose tissue. The present objective was to determine which of the major isomers of CLA contribute to this effect. Mice (N = 72) were blocked by sex and fed: 1) the purified diet, AIN-93G, containing 7% soy oil (n = 18); 2) this diet restricted in offering to the consumption of mice fed diet three (n = 18); or a diet based on AIN-93G but having soy oil replaced (w/w) with 3) 2% CLA (95% conjugated isomers, 0.44% trans10, cis12 CLA, 0.41% cis9, trans11 CLA, Nu-Chek-Prep; n = 12); 4) 0.82% cis9, trans11 CLA (n = 12); or 5) 0.88% trans10, cis12 CLA (n = 12). Feed intake and mouse weight were measured daily for 5 d. The mice were then killed and retroperitoneal fat pads were removed. The remainder of each carcass was freeze-dried and extracted with ether to determine total body fat. Data were analyzed by ANOVA. Mean retroperitoneal fat pad weight of the mice fed diets 1, 2, 3, 4, and 5 was 0.24, 0.22, 0.17, 0.28, and 0.19 g, respectively (SEM = 0.03). Mean fat pad weight was lower for mice fed trans10, cis 12 CLA than for mice fed cis9, trans11 CLA (/italicizeP < 0.05). Percent fat (dry basis) of mice fed diets 1, 2, 3, 4, and 5 was 37.1, 36.2, 32.0, 39.0, and 31.0, respectively (SEM = 2.3). Mice fed trans10, cis12 CLA had less body fat than those fed either cis9 trans11 CLA (/italicizeP < 0.05), the control diet unrestricted (/italicizeP < 0.05), or those fed the control diet at restricted intake (/italicizeP < 0.09).

Our conclusion is that trans10, cis12 CLA causes body fat reduction in mice independent of feed intake, and that cis9, trans11 CLA has no effect on body fat in mice.

**Key Words:** Body Fat, Conjugated Linoleic Acid, Mice

### 354 Foal Vocalizations and and Stress During Weaning. S. Turcott\*, C. Moons, and A. Zanella, *Michigan State University*.

Weaning is an especially stressful period for foals and horse farm manager frequently seek to find ways to determine the degree of stress and ways to reduce stress during weaning. In this study we recorded and analysed distress vocalizations of 10 foals 1 day before, the day of, and one day after weaning. The foals were all between 5 months and 6 months at the time of weaning. The foals were weaned in individual stalls, but two foals were weaned during each trial; they were out of sight, but within audio distance from one another. During each weaning one foal was the control, and had not been separated from its mother during its life. The other foal had incurred regular 10min. separations from birth to 3months each week. Vocalizations were recorded for six sample hours (7-9am, 11-1pm, and 3-5pm) for the day pre-weaning, weaning day, and the day post weaning. The foal vocalizations we recorded on the pre-weaning day are minimal and generally associated with feeding, barn activity, or other circumstances not directly related to foal and mare communication. The vocal calls from the foal on the day of weaning are frequent and in coordination with distress behavioral patterns as recorded by a heart rate monitor, salivary cortisol collections, and behavioral pattern observations. The day after weaning offered the most variation between foals and between the control and experimental group. Generally the foals calls were reduced as compared to the day of weaning; in addition the actual vocalization was different from the previous calls used by the foal both during and before weaning. The collected data collected thus far, supports our hypothesis that through identification and characterization of vocalization patterns in foals at weaning we can predict that repeated separations will decrease the responsiveness of foals to weaning.

**Key Words:** weaning, behavior, vocalizations

### 355 Relationships of ham and loin pork quality measurements. D. M. Price\*<sup>1</sup>, K. W. McMillin<sup>1</sup>, M. A. Persica<sup>1</sup>, R. L. Payne<sup>1</sup>, J. L. Shelton<sup>1</sup>, and J. O. Matthews<sup>1</sup>, <sup>1</sup>*LSU Agricultural Center*.

Pork carcasses (n = 24 barrows) and meat were measured to determine relationships between ham and loin quality traits. The pH was measured with a probe electrode in the Longissimus dorsi at the 10th rib and Gluteus medius at 0, 1, 2, 3, 4, 6, 8, 10, and 24 h post-slaughter. Following a 24-h chill, CIE L\*, a\*, b\* values were determined on the same muscles with a color spectrophotometer. Boneless L. dorsi and G. medius chops (2.5-cm) were suspended from hooks for 24 h to determine drip loss. Eleven carcasses (46%) were classified as pale, soft, and exudative because the 24-h loin or ham pH was below 5.6. Four loin samples (17%) were pale (National Pork Producers Council subjective color score of 1), but only two had a 24-h pH < 5.6. Eight L. dorsi samples had drip losses > 6%, but all G. medius samples had < 6% loss.

Initial loin pH was correlated (r = 0.61; P < 0.001) to 1, 2, and 3-h loin pH, and inversely correlated (r = - 0.63) to L\*, b\*, and drip loss of the loin. The 3-h loin pH was correlated to the 2, 4, 6, 10, and 24-h loin pH (r > 0.65) while 3-h ham pH was correlated only to the 2-h (r = 0.71) and 4-h loin pH (r = 0.64). The 4-h loin pH was positively correlated to the 6 and 24-h ham pH (r = 0.61) and 10 and 24-h loin pH (r = 0.74) and negatively correlated (r = - 0.61) to the L\* loin color value. The 6-h ham pH was correlated (r = 0.74) to the 10-h ham and loin pH and 24-h ham pH. The 10-h loin pH was correlated to the 10-h ham pH (r = 0.77), 24-h ham pH (r = 0.86) and 24-h loin pH (r = 0.80). Loin L\* lightness and a\* redness scores were correlated to the b\* score (r = 0.92 and 0.74, respectively), and loin L\* and b\* scores were correlated (r = 0.74) to the loin percentage drip loss. Ham L\* and a\* scores were correlated (r = 0.63) to the ham b\* scores, but color was not related to drip loss of G. medius. Ham and loin pH, color, and drip loss were not highly related in this study, limiting the estimation of pork quality from a single trait.

**Key Words:** Pork Quality, pH, Color

### 356 Influence of diet type and mixed microbial extract (MME) treatment on intake, digestion, and nitrogen retention in growing ram lambs. T. L. Lawler\*, M. L. Bauer, V. I. Burke, T. C. Gilbery, G. P. Lardy, and J. S. Caton, *North Dakota State University, Fargo*.

Sixteen lambs (51.4 ± 4.2 kg BW) were used to evaluate the effects of diet type and MME on intake, digestion, and nitrogen retention. Treatments were arranged in a 2 × 2 factorial with factors being diet type (alfalfa pellets vs a 75% concentrate, corn-based totally mixed diet) and with or without MME (Cilk; Enviro Consultants Service, Evergreen, CO). Lambs were offered diets ad libitum and MME was provided at 0.125% of diet DM. Mixed microbial extract was included with the total mixed diet for lambs fed concentrate and as a component of a corn-based supplement for lambs fed alfalfa pellets. Supplement was fed daily (84 g/d) just prior to offering basal diet. Lambs were adapted to diets for 14 d followed by 7 d of collections. Dry matter intake was higher (1852 vs 1384 g/d; 36.1 vs 27.2 g/kg BW; P < 0.02) and DM digestion lower (47.6 vs 78.2%; P < 0.01) in lambs fed alfalfa pellets compared with concentrate. Low digestion coefficients associated with alfalfa pellets are likely a result of high intakes and high rates of passage. Mixed microbial extract did not alter DMI or DM digestion (P > 0.22). Mixed microbial extract increased (P < 0.01; 31.2 vs 26.1 %) fecal DM and resulted in less (P < 0.01) total fecal water excretion (1467 vs 2340 g/d). Dry fecal output was not affected (P > 0.34) by MME. Nitrogen intake was greater (P < 0.01) in alfalfa- compared with concentrate-fed lambs. Feeding MME had no influence (P > 0.30) on nitrogen intake or digestion. Interactive means (P < 0.07) for N retention as a proportion of absorbed N were 34.0, 14.6, 25.0, and 40.5 ± 8.5% for alfalfa, alfalfa plus MME, concentrate, and concentrate plus MME fed lambs, respectively. Data suggest that form of diet alters intake and digestion while MME does not. However, MME appears to influence N retention as a proportion of absorbed N in a diet type dependent fashion. In addition, MME did increase fecal DM, which may have waste management implications.

**Key Words:** Intake, Enzyme, Nitrogen Retention