ABSTRACTS
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Animal Behavior, Housing and Well Being

1 Swine production systems: animal welfare considerations. D.C. Lay Jr.*, *Agricultural Research Service-USDA*.

A general public perception is that it is easy to visualize when an animals welfare is adequate. Scientifically, this determination is quite difficult. The difficulty resides in our ability to objectively assess the animals physical and psychological state; as well as to determine the difference between a want and a need. Questions about animal welfare need to be addressed based on individual needs of animals. While productivity and economics can be measured at the group level, animal welfare must be measured at a individual level. Needs are both species and individually specific - dependent on age, sex, temperament, previous experience; characteristics that are lost at the group level. Science has provided a great deal of information that is useful in assessing the physical needs of swine. In contrast, information is lacking on required needs related to social requirements, motivational states, activities #both level and specific activity, as well as psychological needs. To critically address the question of animal welfare, specific questions need to be answered addressing all of the factors mentioned above. Unacceptable welfare in one factor translates to unacceptable welfare for the individual. Our challenge is to be able to define the point at which good welfare turns to poor welfare. However, like feelings of pain, hunger, cold, and thirst; welfare should be viewed on a continuum in which positive welfare becomes less positive and then worsens, or vice versa. Swine production systems should be evaluated as to whether the animals are free from pain, free from distress, free from fear, and as to whether the animals are both physically and psychologically fit.

Key Words: Stress, Welfare, Swine

2 Comparison of finishing systems: impact on health, performance, and carcass composition. J. G. Gentry*[1] and J. J. McGlone[2], [1]*Middle Tennessee State University, Murfreesboro, TN,* [2] *Texas Tech University, Lubbock, TX.*

Traditional or common swine finishing units today have totally or partially slatted concrete floors in a building that might be mechanically or naturally ventilated. Alternative systems include a variety of less common systems such as open buildings with natural ventilation and sunlight exposure (ex. hoop building), open building with outsides access, or outdoors either on pasture or dirt. Alternative systems may become more common as environmental and(or) animal welfare regulations increase. Research comparing performance during the growing/finishing phases of indoor and outdoor systems has been variable. Reasons for variation in production system effects include differences in pig birth and rearing environment, seasonal effects, geographical region, and quality of ground surfaces or bedding. In most reported literature, the health and performance of weaned pigs in an outdoor or alternative environment is comparable to indoor systems. Some studies report that outdoor-born pigs in milder weather or Southern regions have higher growth rates but more backfat, while other studies, generally in more Northern climates, find no difference or reduced feed efficiency among pigs in alternative systems. Increased space allowance, exercise, reduced respiratory pathogen exposure, and increased bacterial or parasitic exposure often are associated with pigs finished in alternative systems. This may account for differences in carcass composition (backfat and muscling) compared to pigs finished indoors. Pig health, including lung lesions and foot lesions, may be improved for pigs in a more extensive system than for those indoors on concrete slats, however, when pigs have a health problem while on bedded or outdoor systems, the disease break can be more intense and less manageable. Individual components of alternative systems (ex. space, bedding, group size, air quality) need to evaluated to find the features that favor improvements in pig health, productivity, carcass traits and welfare.

Key Words: Pigs, Finishing System, Carcass Composition

3 Environmental Enrichment of Swine Production Systems - Implications for Pork Quality? R.E. Klont*, E. Kurt, and A. Sosnicki, *PIC North America*.

Objective of this presentation is to show the potential implications of enriched housing conditions on pork quality. In recent years consumers have become more and more focused on the way that food is produced and intensive animal production is perceived as compromising the welfare of animals. Pork quality can be described by different attributes, which include technological, sensorial, nutritional, microbiological and ethical traits. Technological and sensorial pork quality traits are determined by the rate and extent of postmortem muscle metabolism. Stress in the period around slaughter is known to influence pork quality. Housing conditions may have an effect on the ability of the pigs to respond to preslaughter stress. Pigs that have more exercise than others show

higher glycogen content and more drip loss. This presentation will focus on the effects of environmental enrichment on technological and sensorial aspects of pork quality. The effects of barren (common intensive conditions with slatted floors, 0.7 m2/animal, and 10 pigs/pen) vs. enriched (straw for manipulation and 1.0 m2/pig) were studied. Salivary cortisol concentrations were measured before transport and at the end of the lairage period. At 5 min, 45 min, 4 h, and 24 h postmortem pH, temperature and lactate concentrations were determined in the longissimus lumborum (LL) and biceps femoris (BF) muscles. Capillarisation of the muscle, mean muscle fiber area, color and drip loss after 2 and 5 d storage were determined for both muscle types. Postmortem lactate formation was significantly lower in LL muscles of enriched pigs at 4 an 24 h postmortem. Capillary density and mean muscle fiber area did not differ between both groups of pigs. The percentage drip loss at 2 and 5 d after storage of LL muscle samples from enriched housed pigs was significantly lower than those of the barren housed pigs. Similar results were shown in a recent comparison of meat quality between intensively and free-ranged pigs. It can be concluded that on-farm improvement of animal welfare by environmental enrichment can also lead to beneficial economic effects after slaughter.

Key Words: Housing System, Pork Quality, Welfare

4 A Comparison of Production Costs, Returns and Profitability for Pork Finishing System. J. Kliebenstein* and B. Larson, *Iowa State University*.

A main focus of this presentation will be identifying the economic factors which impact the profitability of the alternative pork production systems. There are many varied types of facilities used in pork production. They range from totally confined environmentally controlled systems to outdoor pasture systems. Moreover, there is a wide range of systems between these two. Examples would include partial confinement and hoop facilities. There are tradeoffs between systems. Totally confined systems are capital intensive but typically have better feed efficiency. Costs referred to as fixed costs such as depreciation, interest, etc. are higher while operating costs or variable costs are lower. Pasture type systems have lower capital requirements but factors such as feed efficiency are typically are not as good. This system has lower fixed costs and higher operating (variable) costs. This paper will provide an economic analysis of alternative pork production systems. It will identify economic factors that differ between systems. These differences can lead to different production decisions respective for pork production system under similar economic conditions.

Key Words: Production Costs, Return, Profitability

5 Effect of thermal and hormonal manipulation of developing chick embryos on post-hatch behavior and physiology. M.J. Toscano*[1], D.C. Lay, Jr.[1], K.A. Scott[1], H.K. Smith [1], and M.E. Wilson[2], [1]*USDA-ARS-Livestock Behavior Research Unit, West Lafayette, IN,* [2]*West Virginia University, Morgantown, WV* .

Stressors applied to pregnant mammals can affect the behavior and physiology of resulting offspring. However, specific mechanisms are difficult to determine due to confounding maternal variables. Developing chick embryos may provide an effective model in studying prenatal stress due their external development. Fertile eggs underwent one of 2 treatments: exposure to an elevated temperature in a 40.6C incubator on d 14, 17 and 19 of development for 24 h (HEAT, n = 176) or application of 60 ng corticosterone to the embryo on d 14, 16, 18 and 20 of development (CORT, n = 176). A third group served as a control and received no treatment (CONT, n = 125). All birds were weighed on d 1, 3, 5, 7,15, and 29. At 7 wk of age, birds underwent Tonic Immobility (TI , N = 58) and/or Open Field (OF, N = 42) tests. The OF was conducted in a pen measuring 3.7 x 2.4 m. Individual birds were placed in the pen for 15 min, after which a novel object was placed in the pen's center and a further 15 min of observations were conducted. Area traversed, time spent in outer, inner and corner areas, flapping of wings, and flying at the front of the pen were quantified. At 11 weeks of age, all birds were sacrificed and adrenal glands were collected and weighed. At hatch, CORT and CONT birds weighed more than HEAT ($p = 0.001$). CORT chicks were heavier than HEAT for the duration of the study ($p = 0.04$), while CONT birds weighed more than HEAT through week 4 ($p < 0.05$). No differences in duration of TI or the OF parameters were found among treatments ($p > 0.10$). Right adrenal glands of CORT birds weighed more than CONT ($p < 0.05$) but not HEAT birds ($p = 0.08$). Though behavior was not affected by treatment, the differences in body weight and adrenal gland weight indicate that prenatal stress affects the physiology of chicks. Paralleling related research in other species, the CORT treatment effectively altered the HPA axis suggesting the utility of this model for future research in the area of prenatal stress. Determining the effects of prenatal stress on behavior, if any, require more investigation.

Key Words: Prenatal Stress, Behavior, Poultry

6 Effects of weaning age on post-weaning belly nosing behavior and umbilical lesions in pigs. R.G. Main*, S.S. Dritz, R.D. Goodband, M.D. Tokach, and J.L. Nelssen, *Kansas State University, Manhattan*.

Our objective was to determine the effect of weaning age on post-weaning belly nosing behavior and associated umbilical lesions. Treatments included weaning litters of pigs from a 7,300-head sow farm at 12, 15, 18, and 21 days of lactation. Sixty-four nursery pens (16 pens per age group, 2,272 total pigs) were used in a randomized complete block design, with off-site nursery as the blocking factor. This study was completed in four blocks (4 pens/age group/block), and all pigs within each block were weaned on a single day into the same nursery. Each pig was individually identified and weighed prior to weaning. Using the individual pig weight and gender information, each nursery pen was allotted with an even number of barrows and gilts, and was representative of the normal weight distribution of pigs weaned within each age group. Each nursery pen was observed for 15 minutes on day 7, 14, and 21 after weaning, and the number of pigs demonstrating belly nosing behavior was recorded. The umbilical region of each pig was examined on day 21 post-weaning following the observation period. Umbilical regions were scored as per the amount of inflammation, swelling, and physical deformity observed (normal = 0, moderate lesion = 5, severe lesion = 15). The proportion of pigs exhibiting belly nosing behavior (21.3, 10.9, 8.9, 5.7 $\pm$ 1.2 %) and umbilical lesion scores (3.80, 2.02, 1.79, 1.75 $\pm$ 0.80) were reduced (quadratic, $P < 0.01$) as weaning age increased (12, 15, 18, or 21 days, respectively). Although numeric reductions in both belly nosing prevalence and umbilical lesion scores continued up through the 21 d old weaned pigs, the most pronounced decrease in prevalence and lesion scores occurred as weaning age increased from 12 to 15 d. This study indicates that weaning pigs less than 15 d of age was associated with increased belly nosing behavior and resulting umbilical lesions. Therefore, weaning age is an important factor to consider when investigating increased rates of belly nosing behavior or umbilical lesions.

Key Words: Weaning Age, Belly Nosing, Umbilical Lesions

7 Behaviors in stalled pregnant females and reproductive performance on a commercial swine farm. T. Sekiguchi* and Y. Koketsu, *Meiji University*.

Our objectives in this study were to observe behaviors in stalled females and to investigate associations between those behaviors and reproductive performances. A commercial farrowing-to-finish farm using a computerized recording system with approximately 300 female inventories was recruited. We visited the farm three times to observe three postural behaviors (lying, standing and sitting) and three stereotypies (vacuum chewing, drinker playing and bar-biting) of stalled females at 5 min intervals for 6 hours (one-zero sampling). Relative frequency of the postural behaviors and the sterotypies for 6 hours were calculated as observed frequency of each behavior divided by the 25 -time observations. Females were categorized into two or three groups by relative frequency of each behavior, because frequency distributions of these behaviors were not normally distributed. Statistical models for reproductive performance included each categorized behavior group, parity and visited month. Visited month was used as a random variable in the Mixed procedure of SAS. In 609 observed females, means in relative frequency of lying, standing, sitting, vacuum chewing, drinker playing and bar-biting for 6 hours were 60.1 $\pm$ 0.91, 32.3 $\pm$ 0.87, 7.6 $\pm$ 0.44, 12.7 $\pm$ 0.65, 0.4 $\pm$ 0.06 and 0.2 $\pm$ 0.05, respectively. Subsequent reproductive performance was extracted by a recording system. In 507 farrowed females, means of total pigs born, pigs born alive, pigs born dead, birth litter weight and adjusted 21days weight were 12.3 $\pm$ 0.13, 11.2 $\pm$ 0.12, 1.1 $\pm$ 0.06, 6.0 $\pm$ 0.19 kg and 17.1 $\pm$ 0.18 kg, respectively. Females showing no-vacuum chewing during gestation produced greater total pigs born (12.5 $\pm$ 0.25 vs. 11.5 $\pm$ 0.36) than those showing high relative frequency (##36%) of vacuum chewing ($P<0.05$). However,

no associations between vacuum chewing and other performances were found. No postural behaviors and other stereotypies were found to be related with reproductive performance. Additionally, farrowing rate was not associated with any postural behaviors and stereotypies in logistic regression models (P>0.05).

Key Words: Vacuum Chewing, Stereotypies

8 The effect of toys on performance and behavior of weanling pigs housed in littermate or mixed groups. C. M. Wood*, B. Osborne, S. Meder, A. Young, A. Damon, J. Joseph, M. Ashby, T. O'Hare, and L. A. Kuehn, *Virginia Tech*.

Two trials were conducted to determine if the addition of a commercially available toy and the mixing of litters had any effect on weanling pig behavior and performance. In each trial, crossbred pigs (n=96) were assigned to treatments at weaning from outcome groups based on litter, gender, and weight. Both trials were conducted in two similar environmentally controlled nursery rooms containing 12 double deck pens each. Each pen (84 cm x 117 cm x 60 cm) housed four pigs. Treatments (toy/no toy and littermate/mixed) were randomly assigned to pens within room in a 2x2 factorial arrangement. All pigs received the same diets, which met or exceeded NRC requirements. Trial 1 lasted two weeks, and Trial 2 lasted four weeks. In Trial 1, five observers recorded pig behavior for a defined period of time in 13 sessions. In Trial 2, one of the five observers recorded behavior four times during the study. In Trial 1 (avg. initial wt = 8.5 kg), pigs with toys tended to gain more (P < .06) than pigs without toys. Pigs with toys also displayed fewer vices (P<.05), but fought more often (P<.05) than pigs without toys. Mixing of litters did not affect growth rate, but pigs in mixed pens did fight more (P<.05) than littermates housed together. In Trial 2 (avg. initial wt = 7.5 kg), littermates gained faster the first week (P<.05), but there was no effect of toy on gain throughout the trial. There were more pig-to-pig interactions among pigs without toys (P<.05) but there were no other significant behavioral differences. There were very few behavioral differences between mixed and littermate pigs, although pigs in mixed pens were observed to drink more often (P<.05). The results of these trials suggest that toys can be effective in reducing unwanted behavioral vices in weanling pigs and may help them to gain faster, but more work needs to be done to clarify results.

Key Words: Weanling Pigs, Behavior, Growth Rate

9 Use of dietary seaweed treatment to reduce heat strain in cattle. L.E. McVicker*, D.E. Spiers, J.E. William, K.J. Barnhart, L.N. Thompson, A. Al-Haidary, and D.P. Colling, *University of Missouri-Columbia*.

Heat stress results in an increase in heat load in cattle, which ultimately reduces productivity. A 50-day study was conducted to determine if a seaweed-derived feed additive, Tasco Meal^{TM} can reduce heat strain in cattle. Twenty-four steers (avg. BW 300 kg) were housed in the Brody Climatology Laboratory at the University of Missouri-Columbia. Each animal was randomly assigned to treatment groups that received either a top dressing of Tasco Meal or control feed daily. Initially half of the animals were exposed to a 13-day heat challenge (HC) reaching air temperatures of 36C during the day and 26C at night. A second 10-day HC period increased night low temperature to 33C and left the high at 36C. During the last portion of the study, animals that had been continuously housed at thermoneutral (TN) were exposed to HC for 12 days to evaluate their heat stress response after receiving Tasco for an extended period. Steers were fed twice daily at 0800 and 1600 with water available ad libitum. Feed intake was recorded daily. Thermal status was measured using telemetric, temperature transmitters (CowTemp, Model BV-010) implanted in the peritoneal cavity. Skin temperatures and respiration rate were taken four times daily. Few significant differences (p≥0.05) were noted between Tasco-treated and control groups. Animals fed Tasco and initially exposed to heat exhibited a visibly lower core temperature (∼0.5C) than control animals. However, there were no significant group differences (p≥0.05) in core temperature. In contrast, animals that received Tasco and were exposed to TN conditions initially showed a visible increase in core temperature above the control animals when exposed to HC after 37 days with no differences in group temperature. Treatment with a seaweed-derived feed additive appears to offer some benefit during early heat stress, but additional studies are needed to verify this benefit.

Key Words: Cattle, Heat Stress, Seaweed

Breeding and Genetics

10 An equivalent single trait animal model to obtain standard errors for estimates of genetic correlations between two traits measured on distinct subsets of animals. K. A. Nephawe*[1], S. D. Kachman[1], and L. D. Van Vleck[2], [1]*University of Nebraska, Lincoln, NE,* [2]*USDA, ARS, USMARC, Lincoln, NE*.

Estimates of genetic correlations among traits are required for economic selection indexes for calculation of expected responses to selection. Such correlations are often estimated using bivariate REML methodology with, for example, MTDFREML programs of Boldman et al. (1995). With two-trait analyses, MTDFREML is able to estimate parameters for bivariate models but the package does not calculate the approximate sampling variances for the estimated (co)variances unless the two traits are measured on all animals. When the two traits are measured on two non-overlapping subsets of animals, the appropriate standard errors can be calculated by reparameterizing the bivariate model to an equivalent single trait model. Reparameterization is done by assigning dummy levels to all fixed and random factors associated with the missing trait when the other trait was measured so that the reparameterized data file contains no missing values. Under the equivalent single trait model, the two direct genetic effects are fitted as two correlated genetic effects so that their covariance is the direct genetic covariance between the two traits. A limitation of the software (not of the approach) is that this equivalent model works only for situations with no true maternal genetic effects for the two traits. The two models can be shown to have the same residual covariance structures. The equivalence was further demonstrated with a numerical example. The standard error for genetic correlation was computed using the equivalent single trait model. An equivalent single trait model could be useful for obtaining the standard error of estimate of genetic correlation between two traits for some situations for which the MTDFREML program currently will not compute the sampling variances.

Key Words: Reparameterization, Sampling Variances, Genetic Parameters

11 Estimates of genetic parameters for first lactation test-day yields of Holstein cows with a cubic spline model. B. J. DeGroot*[1], J. F. Keown[1], S. D. Kachman[1], and L. D. Van Vleck[2], [1]*University of Nebraska, Lincoln, NE,* [2]*USDA, ARS, USMARC, Lincoln, NE*.

The objective was to estimate genetic parameters for individual test-day milk, fat, and protein yields with a cubic spline model. A total of 196,687 test-day records in the first 305-d of 38,172 first lactation Holstein cows that calved between 1994 and early 1999 were obtained from Dairy Records Management Systems in Raleigh, North Carolina for the analysis. Estimates of the (co)variances for the cubic spline with five knots were obtained with REML. Estimates of heritabilities for test-days and estimates of genetic and phenotypic correlations between test-days were obtained from the estimates of variance and covariances from the cubic spline analysis. Genetic parameters were estimated at the average test day within each of the ten 30-d test day intervals. The cubic spline model included herd test-day and age at first calving as fixed effects. Cubic splines were fitted for the overall lactation curve, additive genetic effects, and permanent environmental effects. The cubic splines used five predetermined intervals between days 0, 50, 135, 220, and 305. Estimates of heritability for milk, fat, and protein yields ranged from 0.13 to 0.16, 0.09 to 0.13, and 0.11 to 0.16 for test-day one to test-day ten. Estimates of genetic correlations between test-days ranged from 0.98 to 0.60 for milk yield, 0.98 to 0.40 for fat yield, and 0.99 to 0.64 for protein yield. Estimates of phenotypic correlations between test-days ranged from 0.70 to 0.31 for milk yield, 0.52 to 0.23 for fat yield, and 0.65 to

0.26 for protein yield. The results indicated that estimates of heritability increased over the course of the lactation. Estimates of genetic and phenotypic correlations decreased for test-days further apart.

Key Words: Heritability, Genetic Correlations, Milk Yield

12 A within herd evaluation of Holstein sires for perinatal mortality including birth weight. J. M. Johanson* and P. J. Berger, *Iowa State University, Ames.*

This study explores the effect of sires, birth weight and other factors on perinatal mortality (PM) (alive or dead at 48 h). The Iowa State University dairy farm collected 4528 records of births between 1968 and 1999. The frequencies of PM and dystocia were 7.1 and 23.7%, respectively. Due to the binary nature of the observations, the logistic regression model was used to predict PM using average information restricted maximum likelihood techniques. Heritability was estimated to be 2.8%. The PM model included random sire effects (n=233) ranging from 3.8 to 4.8%. The PM model also included fixed effects of year of birth, season (summer or winter), calving ease (unassisted or assisted), parity (first or later), birth weight (kg), ratio of calf's birth weight to dam's weight (%), gestation length (d), and sire groups (n=5). PM increases by 2.9% per year. Calves born in the winter have a 36% higher risk of PM than calves born in the summer. Difficult births tend to result in PM 2.7 times more often than unassisted births. First parity cows have a 2.6 times higher odds of PM than cows in later parities. Birth weight, ratio of calf weight to cow weight, and gestation length were fit as quadratic factors. Probabilities of PM for birth weights of 29, 35, 40, 46, and 52 kg were 2.4, 2.7, 3.3, 4.9, and 8.7%; and 6.3, 6.9, 8.5, 12.4, and 20.6%, for unassisted and assisted births, respectively. Ratios of calf to cow weight of 4.5, 5.7, 6.9, 8.1, and 9.3% yield probabilities of PM at 3.0, 3.2, 3.3, 3.5, and 3.7%; and 21.8, 11.9, 8.8, 9.2, and 13.5% for unassisted and assisted births, respectively. Gestation lengths of 268, 273, 279, 284, and 290 d yield probabilities of PM of 6.1, 4.2, 3.3, 3.2, and 3.7%; and 15.2, 10.8, 5.6, 8.2, and 9.5% for unassisted and assisted births, respectively. Sire group solutions ranged from 3.7 to 5.4%, but these differences were not significant.

Key Words: Holstein, Birth Weight, Perinatal Mortality

13 Models for a composite trait such as litter weight weaned for Polypay ewes. L. D. Van Vleck*[1], K. J. Hanford[1], and G. D. Snowder[2], [1,2]*USDA, ARS, USMARC,* [1]*Lincoln, NE,* [2]*Clay Center, NE.*

Litter weight weaned (LWW, kg) is the product of a rate trait (number of lambs weaned) and the average weight per lamb weaned and, in this case, is a composite maternal trait of the ewe. Litter weight weaned can be defined on a per ewe exposed basis, on a per ewe lambing basis, or on the basis of a ewe weaning at least one lamb. Depending on which definition is used, the biological and economic meanings of the trait will be different. Variance components for these definitions were estimated from analyses of 9,075 records of 3,487 Polypay ewes from the USSES, Dubois, Idaho. The basic model included fixed effects of age of ewe, year of birth, type of birth and rearing, and random genetic and permanent environmental effects associated with the ewe. For a specific per ewe definition, various covariates which affect LWW also will affect the biological interpretation of estimates of variance components. For example, on a per ewe exposed basis with no other fixed effects, estimates of heritability, repeatability, and phenotypic variance were: 0.04, 0.08, and 531. With 3 covariates to account for fraction of litter weaned being wether or ram or ewe lambs, the estimates were: 0.04, 0.07, 181. With the covariate of number of lambs born, the estimates were: 0.06, 0.11, and 432. With the covariate of number of lambs weaned, the estimates were: 0.11, 0.12, and 45. This pattern was similar per ewe lambing or weaning at least one lamb. When analyzed with either number of lambs born or weaned with fixed effects of age of ewe and year of birth, estimates for LWW were similar to estimates from single trait analyses. The exception was that when analyzed with number weaned and with the 3 covariates for gender of litter, estimates were 0.04, 0.08, and 412 per ewe exposed, 0.04, 0.08, and 405 per ewe lambing, and 0.07, 0.09, and 205 per ewe weaning at least one lamb. An obvious conclusion is that for genetic evaluations which include a composite trait such as LWW, models must be developed carefully for what the specific goals are.

Key Words: Genetic Parameters, Sheep, Variance Components

14 Evaluation of serially measured body weight data in young Angus bulls and heifers. A. Hassen*, D. E. Wilson, and G. H. Rouse, *Iowa State University, Ames, IA.*

Data in the current analysis came from 927 purebred Angus bulls and heifers born during the spring of 1998 to 2001. Each year animals were weighed 4 to 10 times starting at birth to 461 d of age. The broad objective of this study was to identify statistical procedures to be used in modeling serially measured phenotypic data and their possible application in evaluating component ultrasound traits. The specific objectives were to describe body weight changes of bulls and heifers, to evaluate current industry age of calf adjustment factors, and to estimate heritability of growth curve parameters. Both linear and nonlinear(logistic) regression models were used to describe body weight changes. Model R^2, RMSE, and percent absolute bias (PABS) for the best linear model based on bull data were 0.91, 47.9 kg, and 11%, respectively. The corresponding values for heifers were 0.90, 38.59 kg and 11.6%, respectively. Logistic models also showed similar R^2, RMSE, and PABS. For both model types, individual animal regressions showed a better fit as evidenced by lower mean RMSE (9 to 10 kg), PABS (1.8 to 2%), and higher R^2 (0.99) values than those used on data pooled within sex. Bulls showed a higher mean predicted mature weight (763 kg) than heifers (542 kg). Predicted daily weight gain and age at inflection point for bulls were 1.75 kg/d and 296 d, respectively, as compared to 1.24 kg/d and 261 d for heifers. When compared to data adjusted to 205 d using all within animal serial data (ADWT), current industry age of calf adjustment factors introduced an average bias amounting to 2% to 11% of ADWT. Heritability of growth parameters ranged from 0.17 to 0.20, suggesting limited directional changes if selection is based entirely on these parameters. Statistical models that allow for individual animal information may provide an alternative for studying compositional changes. However, with limited number of observations per animal and restricted range of ages at scan, nonlinear growth functions may not provide any better description of changes in body composition than simple linear regression models.

Key Words: Cattle, Growth, Regression

15 Relationship between intramuscular fat percentage predicted from real-time ultrasound and meat quality traits in pigs. D.W. Newcom*[1], T.J. Baas[1], and R.N. Goodwin[2], [1]*Iowa State University, Ames, IA,* [2]*National Pork Board, Des Moines, IA.*

Data from two national progeny testing programs were used to compare the relationships of intramuscular fat percentage of the loin predicted using real-time ultrasound (PIMF) and chemical intramuscular fat percentage (CIMF) with meat quality traits in pigs. A total of 821 purebred (Yorkshire, Duroc, Chester White, Poland China, and Berkshire) barrows and gilts were ultrasonically scanned 5 d prior to harvest with an Aloka 500 SSD ultrasound machine. A minimum of four longitudinal and one cross-sectional ultrasound image were collected. Intramuscular fat percentage was predicted using a model which included image parameters from the longitudinal images and backfat from the cross-sectional image. Chemical intramuscular fat percentage was determined by lab analysis of a slice from the loin at the 10^{th} rib. Meat quality traits measured were: Minolta reflectance, Hunter L, and pH (24 and 48 h); water holding capacity and subjective visual scores for color, marbling, and firmness (48 h); Instron tenderness, cooking loss, and trained sensory panel evaluations (5 d). Traits were grouped for analysis and each group included chemical and predicted IMF. The heritabilities for CIMF and PIMF were 0.45 and 0.52, respectively, and the genetic correlation between them was 0.76. Estimates were consistent across trait groups. Genetic correlation estimates for PIMF and CIMF with pH measured 48 hours post-mortem were 0.40 and 0.27, respectively. The genetic correlations between PIMF and tenderness, juiciness, and flavor evaluated by a sensory panel were 0.29, 0.67, and 0.66, respectively. The genetic correlations between CIMF and tenderness, juiciness, and flavor were 0.35, 0.53, and 0.54, respectively. Genetic correlation estimates for PIMF and CIMF with water-holding capacity were -0.40 and -0.25, respectively. The genetic correlations of PIMF and CIMF with remaining meat quality traits were similar. Selection for intramuscular fat percentage estimated from chemical analysis or by real-time ultrasound should yield similar correlated responses in meat quality traits in pigs.

Key Words: Pigs, Meat Quality, Genetic Parameters

16 Effect of selection for testosterone production on testicular morphology and daily sperm production in pigs. S. Walker*, O.W. Robison, C.S. Whisnant, and J.P. Cassady, *North Carolina State University, Raleigh*.

The objective of this study was to determine effects of divergent selection for testosterone on morphological testicular characteristics and daily sperm production. Duroc boars from lines divergently selected for testosterone production in response to GnRH challenge for 10 generations followed by random selection were used. In generation 21 endogenous testosterone in the high testosterone line (H, n=54) and low testosterone line (L, n=44) averaged 490 ng/dl and 278 ng/dl (P<0.01), respectively. Body weight, testicular weight, and epididymal weight were recorded for boars from H (n=82) and L (n=44) castrated at an average age of 211 d and 97 kg. For animals castrated in generation 20 (H, n=46 and L, n=13) tissue samples were also taken, and volume densities for leydig cells and seminiferous tubules were determined along with daily sperm production per gram of testis. After adjustment for body weight, average paired testicular weights for H and L were 417 kg and 457 kg (P<0.01), respectively. Adjusted epididymal weights also differed between lines (P<0.02), with H having larger epididymal weights. Line H (n=46) had greater volume densities of leydig cells than L (n=13) (P<0.02). Volume density of seminiferous tubules tended to differ between the lines (P<0.07). Daily sperm production per gram of testes once adjusted for age did not significantly differ between lines. Selection for testosterone production in response to a GnRH challenge was an effective method of changing testosterone levels, testicular size, epididymal weight, and volume density of leydig cells and seminiferous tubules. However, no significant difference in daily sperm production per gram of testes was seen with respect to selection for testosterone. At this time selection for testosterone in order to increase sperm production is not recommended.

Key Words: Selection, Reproduction, Pigs

17 Response to selection in purebred and crossbred swine populations selected for growth traits on a maternal index. M. B. Munthala*, T. S. Stewart, A. P. Schinckel, and M. M. Schutz, *Purdue University, West Lafayette, IN USA*.

The objective was to evaluate the correlated response to selection for a maternal index on days to 105 kg (d105) and backfat at 105 kg (BF) in crossbred and purebred pigs. Three replicates of purebred Yorkshire and Landrace, boars and gilts were selected on maternal index (including number born alive, pigs survival to weaning, litter 21-dayweight, d105 and BF). Adjusted d105 and BF were calculated by National Swine Improvement Federation guidelines. Contemporary purebred and crossbred offspring were produced over a period of 7 years. Data were analyzed with purebreds and crosses together (n = 5540) and with subsets of each breed composition category LL (n = 1437), YY (n = 1411), LY (n = 1452), YL (n = 1240). Model included replicate, farrowing group nested in replicate, sex and covariates of birth weight, and weaning weight. Fixed effects of sire and dam breed were included for full data. All effects were found to be significant (P<0.05). Average d105 was 185.32d (±24.2d) and average BF was 19.3mm (±5.5mm). Heritability estimates and genetic correlations were obtained with REML and breeding values were BLUP using PEST. Heritability for d105 ranged from 0.34 to 0.68 (full data 0.48, LL 0.34, YY 0.38, LY 0.55, and YL 0.68). Heritability of BF ranged from 0.38 to 0.56 (full data 0.42, LL 0.38, YY 0.52, LY 0.52, and YL 0.56). Small non-significant genetic correlations (ranging from -0.095 to 0.0163) were found between d105 and BF. Over a period of 7 years, genetic trend for both d105 (d/yr) and BF (mm/yr) decreased, with regression coefficients -1.00 and -0.3 respectively. The breed-wise genetic trend per year for d105 (d/yr) and BF (mm/yr) respectively was LL -0.75, -0.31; LY -0.37,-0.025; YL -0.025, 0.074; YY-0.43, -0.32. The breed-wise phenotypic trend per year for d105 (d/yr) and BF (mm/yr) respectively was LL 4.28, -0.89; LY 4.18, -0.4; YL 5.94, -0.68; YY 4.76, -0.8. Selection for maternal trait index has resulted in a genetic decrease in d105 and BF.

Key Words: Days to 105 kg, Backfat, Response

18 Effects of sire line, sire, and sex on plasma urea nitrogen (PUN), body weight, and backfat thickness in offspring of Duroc and Landrace boars and heritabilities. J. Klindt*, R. M. Thallman, J. T. Yen, and T. Wise, *USDA-ARS, U.S. Meat Animal Research Center*.

In pork production, efficiency of dietary protein (nitrogen) utilization is low, <50%, resulting in urinary excretion of large quantities of nitrogen as urea. Dietary protein accounts for 20 to 25% of the cost of diets and efficiency of its use affects economic efficiency. Utilization of protein and formation of urea are under enzymatic regulation, suggesting genetic regulation. The present study examines the effect of sire line, sire, and sex on growth characteristics and PUN concentrations in the offspring of 11 Duroc sires and 11 Landrace sires bred to Yorkshire-Landrace dams. Plasma samples were obtained at 107, 128, and 149 d of age from 511 boars, gilts, and barrows group-penned and fed a standard finishing diet. Body weight (kg) and backfat (BF, mm, mean of measurements at 1st rib, last rib and last lumbar vertebra) were recorded at time of blood sample collection. Sire line, sire, sex, age, age*sex, and age*line*sire influenced ($P < 0.01$) BW, BF, and PUN. Single observation traits; i.e., ADG (kg/d), BW at 21wk (BW21wk, kg), avg. daily change in BF (ADCBF, mm/d), BF at 21wk (BW21wk, mm), and mean of three PUN measures (mPUN, mg/dL) were generated. All traits were influenced ($P < 0.01$) by sire and sex, and line influenced ($P < 0.01$) all traits except ADCBF ($P > 0.65$). Phenotypic correlations of mPUN with growth traits are: ADG, 0.05; BW21wk, 0.21; ADCBF, 0.23; and BF21wk, 0.42. Genetic correlations of mPUN with growth traits are: ADG, 0.12; BW21wk, 0.44; ADCBF, 0.22; and BF21wk, 0.62. Heritabilities (h^2) are: ADG, 0.64; BW21wk, 0.47; ADCBF, 0.40; BF21wk, 0.57; and mPUN, 0.35. Determination of PUN, as herein, may be with sufficient precision to allow its use in a selection protocol. Selection of pigs with superior growth performance and low PUN may result in greater efficiency of dietary nitrogen utilization and reduced negative environmental impact.

Key Words: Plasma Urea Concentrations, Growth, Genetic Influences

19 Mapping of porcine genes related to human diabetes. C.J. Otieno*, S. Vleck, C. Jelks, K.S. Kim, N.T. Nguyen, and M.F. Rothschild, *Iowa State University, Ames*.

The link between diabetes and obesity is well known, and the pig may present a good model system for studying these complex traits. Resistin (RSTN), an adipocyte hormone, counteracts the effects of insulin while 11 beta hydroxysteroid dehydrogenase isoform 1 (HSD11B1) catalyzes glucocorticoid conversion, and both have been implicated in insulin resistance, impaired glucose tolerance, diabetes and obesity. Protein kinase B Akt2 (AKT2) mediates insulin signaling in muscle and fat cells. We identified polymerase chain reaction- restriction fragment length polymorphisms (PCR-RFLPs) in the porcine RSTN, HSD11B1 and AKT2 genes. A 14 base-pair insertion/deletion SmlI PCR-RFLP in intron 2 of the RSTN gene was detected and used to genotype a reference family generated by intercrossing Berkshire and Yorkshire pig breeds. According to linkage analysis, the RSTN gene was mapped to pig chromosome 2 between the markers SW1686 and SW766. Similarly, we identified a StuI PCR-RFLP in intron 3 of HSD11B1, and linkage analysis mapped this gene to pig chromosome 9 between the markers SW2116 and SW1651. Using the French pig/rodent somatic cell hybrid panel containing 27 cell lines, we physically mapped the AKT2 gene to pig chromosome 6 in the region q21. This study has added three new markers to the pig genome map, and further investigations on these genes in pigs may provide useful information on genetic factors underlying diabetes and obesity.

Key Words: Pig, Gene, Diabetes

20 Characterization of a line of pigs selected for increased litter size for genes known to affect reproduction. C. D. Blowe*, E. J. Eisen, O. W. Robison, and J. P. Cassady, *North Carolina State University, Raleigh*.

The purpose of this study was to characterize changes in allelic frequencies in a line of pigs selected for increased litter size. Genes to be examined were chosen based on results of previous studies, which indicated that a particular polymorphism was associated with an increase in litter size. Pigs were selected from the largest litters where litter size was based on number of fully formed pigs. Litters were standardized at birth

so that no replacement gilts were reared in a litter greater than 10 pigs. A contemporary control line was maintained also. In generation nine, the estimated mean breeding value for litter size was 0.63 pigs larger in the select line than in the control line. DNA was extracted from white blood cells. Alleles were detected using previously published primers and enzymes. Estrogen receptor (ESR) and retinol binding protein 4 (RBP4) loci were amplified using PCR. Product from PCR reactions was then digested with restriction enzymes that have been shown in previous studies to produce restriction fragment length polymorphisms. Digestion using *Pvu* II and *Msp* I were used for ESR and RBP4, respectively. No segregation of ESR alleles was detected in either population. Frequencies of the *A* allele for RBP4 were 0.266 and 0.207 in the select and control lines, respectively. The frequencies were not significantly different between the two lines. Molecular genetics has the potential to be highly advantageous in selection for lowly heritable and sex-limited traits, such as litter size. It may be concluded that changes in litter size observed in this population were not associated with either the ESR or RBP4 locus.

Key Words: Pigs, Reproduction, Litter Size

21 Modeling variance and covariance of total sperm cells over the active lifetime of AI boars. S.-H. Oh*[1], M. T. See[1], T. E. Long[2], and J. M. Galvin[2], [1]*North Carolina State University, Raleigh NC,* [2]*NPD USA, Roanoke Rapids NC.*

The objective of this study was to model the variances and covariances of total sperm cells (x 10^9) over the active lifetime of AI boars. Data from boars (n = 833) selected for AI were provided by NPD USA. Total number of records and animals were 19,629 and 1,045, respectively. Parameters were estimated for total sperm cells by age of boar classification under a random regression model using the Simplex method and DxMRR procedures. The analysis model included breed, collector and year-season as fixed effects. Random effects included additive genetic effect, permanent environmental effect of boar, and measurement error. All measurement errors were assumed to be equal. Observations were removed when the number of data at a given age of boar classification was less than 10. Preliminary evaluations showed the best fit with fifth order polynomials indicating that the best model would have fifth order fixed regression and fifth order random regressions for animal and permanent environment effects. In this study, all combinations within the fifth order were fit to evaluate the best polynomial covariance function. Goodness of fit for models was tested using Akaike's Information Criterion and Schwarz Criterion. The maximum log likelihood value was observed for fifth, seventh, and fourth order polynomials for fixed, additive genetic and permanent environmental effects, respectively. However, the best fit as determined by Akaike's Information Criterion (AIC = 5.799) and Schwarz Criterion (SC = 5.801) was by fitting fifth, sixth, and sixth order polynomials for fixed, additive genetic and permanent environmental effects, respectively. Heritability estimates for total sperm cells ranged from .27 to .61 across age of boar classifications. In addition, heritability for total sperm cells tended to increase with age of boar classification. The cyclic nature of heritability for total sperm cells that was observed over the active lifetime of boars may be due in part to number of observations across seasons limiting our ability to correct for seasonal effects on sperm production.

Key Words: Heritability, Semen, Pigs

22 Performance of mice divergently selected for sensitivity to fescue toxicosis when challenged with endophyte-infected fescue and heat stress. S. Bhusari*[1], E. Antoniou[1], D.E. Spiers[1], W.D. Hohenboken[2], P.A. Eichen[1], and W.R. Lamberson[1], [1]*University of Missouri-Columbia,* [2]*Virginia Polytechnic Institute and State University, Blacksburg.*

Mice, previously selected for sensitivity to endophyte-infected fescue seed diets based on rapid (**R**) or slow (**S**) gain, were used to study the effects of fescue toxicosis during heat stress. Ninety-five mice from the lines were randomly allocated to either heat stress (**HS**, 34 $\pm 1^{\circ}$C) or thermoneutral (**TN**, 24 $\pm 1^{\circ}$C) conditions and diets containing 50% endophyte positive (**E+**; 6 ppm ergovaline) or negative (**E-**) fescue seeds. Mice were exposed to conditions of HS and endophyte diets from 47 to 60 days of age. Body weights were measured on the first day of the experiment (**d1**), day 7 (**d7**) and day 14 (**d14**). At study end, mice were euthanized and the livers weighed (**Lwt**) and frozen for future study of gene expression. Dependent variables, Lwt, body weight gain from d1 to d7, d7 to d14 and d1 to d14, and body weight at d7 and d14, were fitted to a model including the effects of selection line, air temperature, diet, and all possible interactions using the GLM procedure of SAS. The R line gained more weight from d1 to d14 than the S line (1.8 $\pm$ 0.16 g vs. 0.95 $\pm$ 0.14 g, respectively, P<0.01). Body weight gain from d1 to d14 on E+ diet was less than on E- diet (0.91 $\pm$ 0.15 g vs. 1.85 $\pm$ 0.16 g, respectively, P<0.01). There was a Line x Treatment x Diet interaction for Lwt adjusted for differences in body weight (P=0.02). Liver weights were heavier in both R and S mice fed E+ at HS than at TN. In mice fed the E- diet, air temperature did not affect the liver weight within either the R or S line. Interaction among factors for liver weight indicates differences in susceptibility of lines to fescue toxicosis.

Key Words: Fescue Toxicosis, Heat Stress, Endophyte

23 Relationships among Charolais sire expected progeny differences and progeny performance in commercial herds. S. C. Clark*[1], D. W. Moser[1], and R. E. Williams[2], [1]*Kansas State University, Manhattan, KS,* [2]*American International Charolais Association, Kansas City, MO.*

Data on Charolais-sired calves were analyzed to evaluate progeny performance relative to sire EPD in a large data set of commercial crossbred cattle in 31 herds across the United States. The traits analyzed were birth weight (n=3,558) and weaning weight (n=3,615) of crossbred progeny from 224 nationally evaluated sires. Birth weight (BW) and weaning weight (WW) were used to assess response to selection in crossbred progeny. Random regression coefficients estimated for progeny BW on sire EPD were 1.03 $\pm$ 0.09 kg/kg of BW EPD, and for progeny WW, 0.66 $\pm$ 0.11 kg/kg of WW EPD. Published sire BW EPD and WW EPD were averaged and weighted on published accuracy. The average weighted sire BW EPD was 0.39 kg and WW EPD was 7.30 kg with an average accuracy of 0.79 and 0.75, respectfully. Correlations for sire effect solutions in commercial herds with published sire BW EPD and WW EPD were 0.59 and 0.39, respectfully. Sire EPD for birth and weaning weights were positively related to actual progeny performance. Therefore, selection based upon sire EPD should result in change of crossbred progeny performance. This further validates use of EPD as a selection tool for BW and WW in commercial herds. However, WW response was lower than expected, possibly a result of management practices in commercial herds compared to purebred herds.

Key Words: Expected Progeny Differences, Progeny Performance, Sire Effect

24 Relationships between live animal ultrasound predicted intramuscular fat and shear force in fed cattle. L. D. Keenan*, D. W. Moser, D. R. Eborn, and T. T. Marston, *Kansas State University, Manhattan, KS.*

Simmental sired (n=136) and Hereford (n=148) feedlot steers were ultrasonically evaluated for intramuscular fat deposition at the 12-13th rib site using CPEC and Critical Vision, Inc. ultrasound systems. Warner-Bratzler Shear Force (WBSF) measurements were taken on postmortem steaks from the 13th rib region of the hindquarter to determine whether shear force values were associated with amount of intramuscular fat projected by the ultrasound systems. Differences between ultrasound and actual marbling measurements were corrected for bias and identified as CPECDEV and CVIDEV, respectively. Simple Pearson correlation coefficients of CPECDEV and CVIDEV with WBSF were .18 and .15, respectively. This indicates that animals overestimated for marbling had a tendency to have higher WBSF values. A linear model was used to describe effects of marbling, WBSF, breed, and breed x WBSF interaction on CPECDEV and CVIDEV. WBSF and breed x WBSF were not statistically significant effects (P>.05) on CPECDEV or CVIDEV. This research indicates that animals with higher ultrasound marbling predictions as compared to the actual carcass marbling score are not associated with higher WBSF values. Thus, CPEC and CVI predictions of intramuscular fat are not biased by differences in WBSF.

Key Words: Intramuscular Fat, Ultrasound, Warner-Bratzler Shear Force

25 Functional genomics as a tool for integrated polygene discovery for complex traits. D. Pomp*, *University of Nebraska-Lincoln*.

Most phenotypes with agricultural and biomedical relevance are multifactorial traits controlled by complex contributions of genetic and environmental influences. Genetic predisposition results from combinations of relatively small effects of genetic variations within a large number of polygenes, known as quantitative trait loci (QTL). Molecular biology has yielded advancements in understanding many complex traits at the metabolic and physiological levels; however, despite the mapping of many QTL for important traits (e.g. growth, body composition, reproduction) across several mammalian species including mouse, rat, pig, sheep, cattle and human, little has been learned regarding the identity and nature of the underlying genes due to the inherent inaccuracy of QTL localization and the inability to differentiate between co-localization and co-incidence. This wide gap between our knowledge of physiological mechanisms underlying complex traits and the nature of genetic predisposition to complex traits significantly impairs polygene discovery efforts. Integration of experimental approaches to jointly evaluate predisposition and physiology should increase success of polygene discovery and characterization by combining the power of recombination with functional analysis. For example, key transcriptional, proteomic, metabolomic and endocrine pathways can be phenotyped in large populations for which marker genotypes are available. By measuring such sub-phenotypes within the framework of a structured gene mapping population, we can bridge the gap between physiology and predisposition to facilitate accurate selection of candidate genes representing QTL, thus enabling complex trait polygene identification and characterization. Such efforts would advance our understanding of the overall genetic architecture of complex traits by testing the central hypothesis that genes controlling predisposition to a complex trait are primarily involved in trans-regulation of the physiological pathways that directly regulate the trait.

Key Words: Genomics, Microarray, Gene Discovery

26 Proteomic analysis of skeletal muscle calcium homeostasis. M. Zeece*, S. Jones, R. Cerny, J. Schultz, N. Palmer, and B. Kornilaev, *University of Nebraska, Lincoln*.

Calcium homeostasis is a critical process in muscle because this cation represents the trigger for several physiological functions including metabolism, contraction and protein turnover. There is also evidence that calcium level is linked to apoptosis and programmed cell death. Abnormal regulation of calcium level is widely held as the principle cause of pathological conditions such as malignant hyperthermia and central core disease in humans. Malignant hyperthermia is also manifest as stress syndrome in meat animals. This condition often results in premature death or poor quality meat (PSE).
Significant progress has been made in the past decade regarding our understanding of calcium regulation and in the identification of potential causes for its abnormalities. The discovery of a single mutation in ryanodine receptor (RyR1) protein stirred hopes that definitive testing would eliminate or reduce the incidence of PSE in pigs. However, this has not yet been realized. A more complicated picture has emerged from recent research. For example, numerous (>20) mutations have been identified in RyR1 that correlate with malignant hyperthermia in humans. It has also been shown that calcium homeostasis results from the coordinated interaction of several SR-associated proteins including: RyR1, dihydropyridine receptor, calsequestrin, tradin, junctin and calmodulin. These proteins form a functional complex that is responsible for calcium release following their interaction. Thus there may be multiple mutations in porcine muscle that collectively contribute to elevated calcium level and its adverse consequences for meat animals.
Our group has taken a proteomic approach to investigate this complex protein system. Two-dimensional electrophoresis in combination with mass spectrometry methods are being used to separate, identify and characterize constituent SR proteins. This group of membrane proteins represents significant challenges to widely used proteomic methods. Thus we have developed techniques to enable their assessment. We are particularly interested in investigating whether additional polymorphisms exist in the porcine form of RyR1 protein. The results of this work including separations of SR-associated proteins and their identification will be presented.

Key Words: Calcium Homeostasis, Proteomics, PSE

27 Design and analysis of cDNA microarrays in animal science. R. J. Tempelman*, *Michigan State University, East Lansing*.

Gene expression experiments based on cDNA microarrays have established a new paradigm for animal science research. Until very recently, however, not enough consideration had been given to experimental design issues such as randomization and biological versus technical replication. Furthermore, the nature of cDNA microarray data seems to require the use of various data adjustments or 'normalization' procedures and the consideration of multiple sources of variation. Design and data quality considerations pertinent to cDNA microarray experiments are discussed. Analyses of cDNA microarray data currently appears to require two types of data normalization: 1) a dye-intensity based normalization and 2) a second normalization based upon a mixed effects model analysis. Both analyses are readily computed using SAS statistical software. Nevertheless, plenty of design and data analysis issues remain unresolved and require further investigation, including the use of control genes, inference involving low level transcripts, non-normal data, and multiple testing.

Key Words: Design of Experiments, Functional Genomics, Mixed Effects Models

28 Application of expression profiling technology to animal agriculture. J. C. Byatt*, N. Mathialagan, and C. J. Dyer, *Monsanto Company, St. Louis, MO*.

The advent of technologies that allow relative expression of thousands of transcripts to be examined simultaneously has made possible a multitude of potential discovery projects that promise to enhance our knowledge of gene function and gene interactions. As expression profiling technology has become more widely available it has been enthusiastically implemented by animal scientists, but several challenges remain with respect to designing meaningful experiments, analyzing and sharing data and generating results with obvious utility. These issues are particularly acute when applied to industrial research, because ultimately a cost/benefit analysis must be carried out for research projects and there should be a clear application of technology investments to a final product. In the case of expression profiling, there are two obvious applications of this technology to product development for animal agricultural companies. The first is to use this technology to identify targets for therapeutic drugs and productivity enhancers. This parallels the pharmaceutical industry's use of expression profiling to identify "drugable" targets. The second application is to use gene expression data to identify potential candidate genes in which genetic variation contributes to QTL. In theory, identification of genes, levels of expression of which are associated with commercially important phenotypes, helps identify positional candidate genes for QTL. In practice, the case for using expression profiling to identify positional candidates will depend on many factors, including 1) number and type of tissues that could express genes controlling the trait, 2) whether these tissues are amenable to serial sampling, 3) the ability to manipulate the phenotype or select and sample animals with a large degree of phenotypic variation and 4) resources for discovering polymorphisms in a potentially very large number of gene candidates. These issues will be explored and illustrated with some examples from a number of expression profiling studies.

Key Words: Expression Profiling, Candidate Gene

29 Nonparametric analysis of the effects of inbreeding on production traits and somatic cell score in US Jerseys. D. Gulisija*, D. Gianola, and K. A. Weigel, *University of Wisconsin, Madison*.

Under dominance, the relationship between a quantitative trait and the inbreeding coefficient (F) is a straight line. If epistatic interactions between dominance effects exist, the relationship is no longer linear. Local regression methods were employed to examine the relationship between F and somatic cell score (SCS) and milk, protein, and fat yield. First lactation records of 134,634 Jersey cows calving between 1995 and 2000, and having at least 3 generations of known pedigree were used. Inbreeding of cows ranged between 0% and 33.3%, with a median of 4.5%. The 25^{th} and 75^{th} percentiles of the distribution were 3.2% and 6.6%, respectively. BLUP residuals from a linear model accounting for herd-year-season, age at calving, days in milk and additive genetic effects,

were analyzed. Nonparametric curves were fitted to these residuals using Lowess regression with F as covariate. Several spanning parameters and linear and quadratic local polynomials were explored. The relationship between performance and inbreeding was complex and nonlinear. For yield traits, the Lowess curves revealed that performance did not decrease for inbreeding up to 7%, but it was reduced thereafter. Seemingly, there was no additional inbreeding depression in cows with F larger than 20%. However, only 246 cows had F $\geq$ 20% and selection effects cannot be ruled out. It may be that these animals represent the result of purging inbreeding depression. For SCS, the relationship with F was flat indicating that this is essentially an additive trait. The effects of inbreeding on performance seem more complex than what is suggested by standard quantitative genetics theory.

Key Words: Inbreeding Depression, Lowess Regression, Somatic Cell Score

30 Analysis of the relationship between linear type traits, inbreeding, and survival in US Holstein cattle. D. Caraviello*, K. Weigel, and D. Gianola, *University of Wisconsin - Madison USA.*

Survival analysis through a Weibull proportional hazards model was applied to evaluate the effect of 15 linear type traits, final score, 5 composite traits, milk production and inbreeding on survival of US Holstein cows. A total of 745,432 cows with first calving from 1993 to 2000 and type classification were used in this study. These cows were divided into 9 regions following the U.S. Standard Regions for Temperature and Precipitation provided by the National Climatic Data Center. True survival was defined as days from first calving until culling or censoring and functional survival was defined as days from first calving until culling or censoring corrected for 305-d mature equivalent milk production. Our model included time-dependent effects of herd-year-season of calving, parity-stage of lactation and the interaction between within-herd-year quintiles for mature equivalent milk and year, as well as time-independent effects of inbreeding, age at first calving, and linear type traits (analyzed one at a time). Different rho and gamma parameters for the Weibull distribution were estimated for each one of the nine regions. Each type trait was divided into ten classes, its impact on true and functional survival in each one of the nine regions, after accounting for all other factors listed above, was evaluated. The results show differences among regions in the risk of culling for almost all the type traits, these differences are clearer when we compare regions extremely different in temperature and precipitation like South East, East North Central, and West. It seems reasonable to consider regional differentiation in the weights given for type traits in the indexes used for selection of Holstein cows, and temperature and precipitation seem to be good parameters for this differentiation. Udder traits had the highest contribution to the likelihood in all regions and should be the main focus of selection when the goal is to increase survival.

Key Words: Survival Analysis, Holstein, Temperature and Preciptation

31 Estimate of heritability and genetic change for survival of Hereford cows. G. E. Martinez*[1], R. M. Koch[1], L. V. Cundiff[2], K. E. Gregory[2], S. D. Kachman[1], and L. D. Van Vleck[2,3], [1]*University of Nebraska, Lincoln, NE,* [2,3]*USDA, ARS, USMARC,* [2]*Clay Center, NE,* [3]*Lincoln, NE.*

Genetic parameters for survival measured in years between first calving and disposal were estimated using records for 2,053 Hereford cows born from 1964 to 1979 from a selection experiment with three lines selected for weaning weight (WWL), yearling weight (YWL), and an index of yearling weight and muscle score (IXL), and a control line (CTL). The model included year of birth as the only fixed factor and sire as the only random factor. The numerator relationship matrix accounted for all known relationships among sires. The survival analysis was carried out with a Weibull model with a penalized quasi-likelihood function. A record was considered censored if a cow was still alive at the end of the experiment or was sold or culled for reasons not related to the experiment. Genetic trends were estimated by regressing weighted means of estimated breeding values (EBV) of sires for years of birth of their daughters on birth year of the daughters. Environmental trends were estimated by regressing means of solutions for year of birth of the daughters on birth year. The estimate of the Weibull parameter was 1.30$\pm$0.14, which indicates that the hazard for being culled increased with age. The overall median survival time was 5.2 years. The estimate of heritability $\pm$ SE for survival was: 0.06$\pm$0.02 on the log scale and 0.15 when transformed to the original scale (years). Estimates of annual genetic change for survival were nearly zero for all lines. Selection of sires whose daughters are more likely to remain longer in the herd would be possible in a breeding program but could be relatively slow due to the low estimate of heritability. Comparison of changes in survival time for the selection and control lines showed that selection for weights at weaning and yearling ages had little effect on survival time in this experiment.

Key Words: Beef Cattle, Longevity, Selection

32 Birth and weaning traits of topcross progeny of Hereford, Angus, Brangus, Beefmaster, Bonsmara, and Romosinuano sires. Larry V. Cundiff, *USDA, ARS, U.S. Meat Animal Research Center.*

The objective of this experiment was to characterize breeds representing diverse sources of germplasm for preweaning traits that are important in beef production. Data were obtained on 1,270 calves born in the spring of 2001 and 2002 and 1,231 calves weaned resulting from artificial insemination matings of Hereford (H, 22 sires), Angus (A, 22), Brangus (Bg, 21), Beefmaster (Bf, 22), Bonsmara (Bo, 19), and Romosinuano (Ro, 20) 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 205-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, BW, and WW, but not for CE or SW. The means for H, A, Bg, Bf, Bo, and Ro sired progeny were 283.7, 281.6, 284.9, 286.6, 286.7, and 288.9, respectively for GL with a mean least significant difference (LSD<.05) of 1.6 d. Corresponding sire breed means were 94.4, 97.2, 96.9, 95.6, 97.7, and 99.2% for CE (LSD<.05 = 3.4%); 41.3, 39.5, 41.1, 43.3, 41.0, and 38.4 kg for BW (LSD<.05 =1.3 kg); 96.9, 98.1, 96.8, 96.4, 94.7, and 98.6% for SW (LSD<.05 = 3.3%); and 242.4, 245.6, 248.9, 254.0, 242.0, and 230.1 kg for WW (LSD<.05 = 4.9 kg). H and A, which have evolved in temperate climates, had significantly shorter GL than Bf, Bo, and Ro, which are considered more tropically adapted. Ro and A had significantly lighter BW than Bo, Bg and H which were in turn lighter than Bf. WW were significantly heavier for Bf than all other breeds. Bg had significantly heavier WW than H and Bo. WW of Ro were significantly lighter than all other breeds.

Key Words: Beef Cattle, Breeds, Germplasm

33 Evaluation of predicted milk yield and weaning weight in Polled Hereford, Angus, Brangus, Gelbvieh, Limousin, Salers, and Simmental Breeds of beef cattle. J. P. Cassady*, C. H. Brown, and O. W. Robison, *North Carolina State University, Raleigh.*

The objective of this experiment was to measure breed differences in predicted milk yield (PMY, a trait of the cow) and weaning weight (WW, a trait of the calf). Data included 935 records from a breed evaluation project at the North Carolina Department of Agriculture Tidewater Research Station, Plymouth, NC. Breeds included were Polled Hereford (PH), Angus (AN), Brangus (BN), Gelbvieh (GV), Limousin (LM), Salers (SA), and Simmental (SM). Milk yields were predicted from three measurements of milk production. The model included fixed effects of calving year (CY), age of dam at calving (ADC), sex of calf, and age of granddam at time of dam's birth (AGD). Calf birth weight and breed type were treated as fixed regression covariates. Direct genetic breed effects were estimated as deviations from the mean performance of PH. Fixed effects of CY and ADC (P < 0.01) and AGD (P < 0.07) were important. Calf birth weight affected PMY (P < 0.01). All possible combinations of single degree of freedom contrasts between breed types were done. Direct genetic effects of PH reduced PMY when compared to AN, BN, GV, SA, and SM (P < 0.05). Simmentals had a greater PMY than AN, BN, and SA (P < 0.05), and GV had greater PMY than LM (P < 0.05). Simmental's greater PMY was expected because SM was developed as dual-purpose breed and thus, selected for milk yield as well as meat production. For WW fixed effects of CY, ADC, sex of calf, and AGD were significant. Birth weight was also important (P <

0.05). Direct genetic effects of AN, BN, GV, SA, and SM increased WW as compared to PH ($P < 0.05$). Direct genetic effect of SM increased WW as compared to SA and LM ($P < 0.05$), and direct genetic effect GV increased WW as compared to LM ($P < 0.05$). Breed differences do exist for PMY and WW. Maximizing net return on assets should be the goal of all beef producers. Increasing calf-weaning weight while lowering cow maintenance costs and increasing rebreeding rates would be expected to improve net return on assets for cow-calf producers.

Key Words: Beef Cattle, Genetics, Weaning Weight

34 Germplasm evaluation in beef cattle: Cycle IV: Post weaning growth and feed efficiency. G. D. Snowder*[1], L. V. Cundiff[1], R. M. Koch[2], and K. E. Gregory[1], [1]*USDA, ARS, USMARC, Clay Center, NE* , [2]*University of Nebraska, Lincoln, NE.*

Breed effects on post weaning growth and feed efficiency traits were compared on 785 F1 crossbred steers out of Angus or Hereford dams and sired by Angus, Charolais, Galloway, Hereford, Longhorn, Nellore, Piedmontese, Salers, or Shorthorn bulls. Steers averaged about 155 d of age at weaning across years (1986 to 1990). Post weaning traits were observed on steers fed within sire breed group in two to three replicated pens per year for approximately 272 d. Steers were slaughtered serially in three or four slaughter groups spanning 56 to 63 d. Quadratic regressions of pen mean weight on days fed and of cumulative metabolizable energy consumption (ME) on days fed were used to estimate gain, ME consumption and efficiency (Mcal ME/kg gain) over time (0 to 226 d on feed) and weight (250 to 500 kg) intervals, and from d 0 to a small degree of marbling and to a 21.6% fat trim end point. Data were analyzed by least squares, mixed model procedures and linear regression to derive contrasts at age-constant, weight-constant, marbling end point, and fat end point. On a time and age constant basis, Charolais and Shorthorn sired crosses were faster growing than other breed types. Growth rates of Longhorn, Galloway, and Nellore-sired crosses were slower compared to other breed types. Rank of sire breeds changed significantly when marbling and percent fat trim end points were considered. Growth rate of Shorthorn-sired crosses to the marbling end point was the slowest. Growth rate of Piedmontese-sired crosses was the fastest to the fat trim end point. Feed efficiency in age and weight constant intervals was highest in Charolais crosses; and lowest in Piedmontese, Nellore, and Longhorn sired crosses. At a marbling or fat trim end point, rank of feed efficiency for Charolais crosses decreased significantly while the rank of Hereford-Angus crosses significantly improved. Breed rankings varied depending on end points.

Key Words: Breed, Biological Type, Marbling

35 Validation of a genetic algorithm for identification of livestock for germplasm preservation. L. L. Melton*[1], P. J. Lamberson[2], R. A. Brenneman[3], C. C. Chase, Jr[4], and W. R. Lamberson[1], [1]*University of Missouri-Columbia,* [2]*Columbia University, New York,* [3]*Omaha's Henry Doorly Zoo®,* [4]*USDA, ARS, Sub Tropical Agricultural Research Station (STARS), Brooksville, FL.*

As livestock production intensifies, a loss of genetic diversity has been observed because of increased use of a few breeds to the exclusion of many others. To preserve diversity the USDA has initiated a program of germplasm preservation through freezing semen. An algorithm to identify least-related animals using pedigree relationships has been developed. Preliminary testing of the algorithm showed that mean relationships between selected animals increased as the proportion of animals preselected increased. In order to test the efficacy of the algorithm in maintaining genetic diversity, data from a pedigreed population of Romosinuano cattle genotyped for 28 microsatellite markers was evaluated. The proportion of total alleles in the population that were maintained in the samples identified for preservation was calculated and comparisons made among methods of identification. An index calculated by summing the inverse of frequencies of all alleles for each individual was determined and animals were ranked on the index. When initiated with a single random seed and 25% of the population was identified by the algorithm for selection, 85% of the alleles in the population were captured in the selected sample. When 40% of the population was selected, the proportion of alleles captured increased to 89%. However, when identifying 25% and the single seed used to initiate the algorithm was the highest indexing animal, 88% of the alleles in the population were captured. When identifying 40% and the single seed used to initiate the algorithm was the highest indexing animal, 93% of the alleles in the population were captured. Additional testing is needed to establish how the algorithm performs with multiple seeds. The algorithm has been used to evaluate the Hereford Swine Association Registry to identify boars for germplasm preservation.

Key Words: Genetic Diversity, Germplasm Preservation, Swine

36 Accuracy of detecting quantitative trait loci by selective DNA pooling. J. Wang*[1], J. Fulton[2], and J. Dekkers[1], [1]*Iowa State University, Ames,* [2]*Hy-Line International, Dallas Center, IA.*

Selective DNA pooling is considered an efficient method to detect quantitative trait loci (QTL) but is subject to errors inherent to the creation and evaluation of pools. The objective of this study was to compare QTL detection results using DNA pooling data vs. results using individual genotyping in an F2 family of layer chickens. A total of 192 F2 females from 11 full-sib families were generated by crossing two commercial pure lines. High and low pools were generated for each of 12 egg production traits by pooling DNA from the top and bottom 20% of progeny ranked by BLUP EBV. High and low pool allele frequencies were estimated for a total of 184 microsatellite markers across the entire genome. A Chi-square test for frequency differences was used to identify markers associated with the QTL. Two chromosomes with significant QTL for some traits were chosen for further analysis using individual genotyping of the entire family by least squares regression interval mapping. On these two chromosomes, 22 markers were used for DNA pooling. These, plus 23 additional markers were used for individual genotyping. Individual genotyping resulted in very similar results as DNA pooling despite the larger number of markers genotyped and analysis of the whole family instead of pools of the tails. Graphs of comparison-wise p values (P) across the chromosome were similar for both methods. The correlation between the Chi-square and the F test values based on $\log10(1/P)$ was 0.7 across traits. At $P<0.01$, a total of 8 QTL were detected for the 12 traits using individual genotyping. Five of these QTL were also significant at $P<0.01$ using DNA pooling data. Of the 6 QTL detected at $P<0.01$ with DNA pooling, one was not found using individual genotyping. In conclusion, selective DNA pooling data is extremely useful in capturing most of the information for QTL detection with a reduction in genotyping costs of approximately 100 fold compared with individual genotype data.

Key Words: QTL Mapping, Selective DNA Pooling

Extension

37 Use of the NRC model to predict forage and/or energy intake and animal performance. D. C. Adams*[1] and H. H. Patterson[2], [1]*University of Nebraska-Lincoln,* [2]*South Dakota State University-Brookings.*

Based on applications of the 1996 NRC (Nutrient Requirements of Beef Cattle, 2000 update) model at our laboratories and in using the model to evaluate published literature, it is our assessment that the NRC model (Level 1) is a major advancement for nutrition and management for grazing cattle. We have demonstrated that the NRC model is useful in developing hypotheses, determining nutrient status, identifying limiting nutrients and needed inputs, and in evaluating published research. The NRC model gives reliable and useful estimates of gains in body weight and/or body condition score and forage intake of beef cattle. From estimated forage intake and performance, effective supplement and/or management practices can be developed and experimental outcomes evaluated. Because of the difficulties associated with measuring forage intake by grazing cattle, the high variability that exist between reports of forage intake within and between classes of grazing cattle, and the impracticality of measuring intake in production settings, the NRC model is a significant improvement in resources available to managers and researchers for estimating forage intake and determining nutrient needs of grazing cattle. The model is useful for evaluating nutritional

scenarios (i.e. what if?) related to the nutrient needs of the cow, nutrient content of forages and need for supplemental nutrients. For example, effects of physiological status of the cow at a given point or throughout the year could be evaluated and factors such as calving or weaning date could then be adjusted to fit low or high quality forages. Model adjustments for cold environments and grazing activity appear to overestimate maintenance requirements. The key to application of the model for research or production is reliable description of the nutrient composition of cattle diets. Descriptions of cattle diets for a broad range of grazed forages are needed or need to be made more readily available to users of the model.

Key Words: Intake, NRC, Cattle

38 Application of the metabolizable protein system to range cattle nutrition. H. H. Patterson*[1] and T. J. Klopfenstein[2], [1]*South Dakota State University-Brookings*, [2]*University of Nebraska-Lincoln*.

The 1996 Nutrient Requirements of Beef Cattle (NRC) adopted the use of the Metabolizable Protein (MP) System, which distinguishes protein requirements of rumen microbes from requirements of the animal. We have found broad application of the MP system, by use of Level 1 of the NRC model, to range cattle research and management. A key to application of the MP system is accurate estimation of the efficiency of microbial CP production. Microbial efficiency estimates are important to predict both degradable intake protein (DIP) and undegradable intake protein (UIP) requirements. Research shows microbial efficiency as low as 8.0% of digestible organic matter intake for gestating cows consuming low quality diets, which supports recommendations in the NRC that adjustments to the default 13% may be necessary in these situations. Reports on positive effects of protein supplementation to gestating cows consuming low quality forage are consistent with DIP deficiencies calculated using the MP system. Recent reports showed that supplementing heifers during gestation to meet NRC estimated MP requirements had little impact on weight or body condition score change but significantly improved subsequent pregnancy rates. Lactating young cows, which are often predicted to be deficient in MP, have been shown to respond to UIP supplementation. The response of grazing yearlings to UIP supplementation is consistent with estimated MP deficiencies, but the model may not accurately predict MP requirements of yearling cattle compensating for prior growth restrictions. At this time, the MP system set forth by the 1996 NRC (Level 1) appears to function well in determining the MP requirements of range cattle. Work is needed to define and model the efficiency of microbial CP production across various diet qualities, animal ages, and physiological states. In its current form, the MP system has application in allowing for more accurate and efficient supplementation of protein to range cattle.

Key Words: Metabolizable Protein, Range, Cattle

39 Considerations for program feeding and use of co-product feeds in cow diets. D. B. Faulkner*, *University of Illinois*.

For many years hay has been the primary feed for wintering beef cows. Little attention has been paid to least-cost diets or alternative feeding strategies like program feeding (feeding a limited amount of a high energy feed to get a desired level of performance). With grain being a cheaper source of energy than hay and the proliferation of co-product feedstuffs, there are opportunities to feed cows much cheaper than with traditional hay diets. We have investigated different diets based on corn and co-products and have found the diets to work quite well. They have also been quite economical. Often the saving are over one dollar per cow per day compared to traditional hay diets. Cattle on these diets consistently perform better than NRC predictions. This is due to several factors. We have observed increased digestibility with program fed diets. Visceral organ weight is also reduced with program feeding. This reductions in organ mass could result in reduce maintenance requirements because these tissues are so metabolically active. These diets also reduce manure production by over 75% compared to hay diets. This could have environmental and labor benefits for producers. We have also seen less variation in cow performance with the program fed diets than hay diets; however, information on large scale program feeding is not available. The only problem we have observed with limit feeding is when we feed diets that are very low in roughage. On these diets cows will chew fences. Feeding of at least 10-15% roughage in the diet alleviated this behavior. Program feeding of grain and forage based diets offers an attractive alternative to beef producers for feeding their cows in the winter.

Key Words: Co-products, Limit Feeding, Program Feeding

40 Characterization of forages for protein and energy. D. L. Lalman* and J. B. Banta, *Oklahoma State University*.

Characterization of forage protein and energy are necessary to design low cost, effective supplementation programs to meet production objectives and to estimate performance of forage fed animals. Forage quality indices estimate energy intake when forage is fed alone. Relative Feed Value (RFV) has been widely used and estimates voluntary intake of energy from forage using an estimate of voluntary forage dry matter intake (VFI) and digestible dry matter (DDM) concentration in the forage. In the RFV calculation, VFI is assumed to be a constant 1.2% of body weight. However, NDF intake is not constant and NDF is not closely associated with VFI ($r^2 = 0.06$, Moore and Undersander, 2002) when beef cattle are fed diets comprised primarily of grasses. Prediction of animal performance and supplementation needs requires an estimate of VFI. In one sensitivity analysis, VFI was the most important factor in estimating metabolizable protein supply using Level One of the 1996 NRC Beef Cattle Requirements (Lalman and Lardy, 1998). Because of the importance of VFI in predicting metabolizable protein supply and animal performance, more research should be focused on the development of more accurate means of predicting VFI for beef cattle fed forage-based diets. In the RFV system, DDM is assumed to be a linear function of forage ADF concentration. Many commercial laboratories continue to use this component of the RFV system to estimate DDM or TDN. In the review of Moore and Undersander (2002), ADF concentration of 70 grass hays was related to DDM ($r^2 = 0.51$) although differences between observed and predicted values were large in many cases. More recently, a summative equation (NRC, 2001) has been recommended to estimate DDM or TDN. This equation considers the digestibility of CP, fatty acids, NDF, and non-fiber carbohydrates independently, as well as an adjustment for metabolic fecal loss. Perhaps the greatest limitation with this approach is the prediction of NDF fiber digestibility. In vitro NDF digestibility or NIR estimates of NDF digestibility may provide practical solutions to this problem.

Key Words: Forage Intake, Forage Quality, Beef Cattle

41 Building a nutritional program with the 1996 NRC Beef Cattle Requirements Model. G. P. Lardy*, *North Dakota State University*.

Designing a sound nutritional program for cow-calf operations requires knowledge of the animal's nutrient requirements, diet quality, and intake. Effectively using the 1996 NRC Beef Cattle Requirements model also requires some understanding of protein degradability of dietary ingredients and microbial efficiency. Work continues at many institutions to determine protein degradability of native range, microbial efficiency of forage-based diets, and forage intake. This information will provide valuable input for model users. Without accurate information, model usefulness is limited. Model validation research is also necessary. In order to develop a cost effective supplementation program, model inputs must be accurate. Model estimates of degradable intake protein balance are most sensitive to microbial efficiency and supplement protein degradability estimates. Model sensitivity to forage protein degradability depends upon the degradability estimate (and consequently the method used to determine degradability). Estimates of metabolizable protein balance are sensitive to dry matter intake and forage protein degradability. Researchers at land grant institutions interested in nutrition of forage-fed beef cattle should focus on three areas to improve model acceptance: 1) development of cost effective, accurate commercial laboratory procedures to estimate protein degradability, 2) development of reliable estimates or indicators of microbial efficiency for various forage types and qualities, and 3) continued validation work to improve estimates of degradable intake protein and metabolizable protein requirements. Currently, to effectively use the 1996 NRC Beef Cattle Requirements Model to estimate protein requirements, users should focus on three key areas: 1) estimates of protein degradability, 2) estimates of microbial efficiency, and 3) estimates of dry matter intake. Users should evaluate existing laboratory data regarding forage protein degradability

and validation data from the literature prior to making dietary recommendations based on the model. As with any computer program, the output is only as accurate as the inputs.

Key Words: Cattle, Protein, Requirements

42 Considerations to help avoid transition cow mineral disorders. J. Goff*, *USDA-ARS National Animal Disease Center.*

Around the time of calving it is not unusual for the dairy cow to suffer some degree of hypocalcemia, hypophosphatemia, hypomagnesemia, and/or hypokalemia. In some cases the severity of these electrolyte imbalances can cause clinical disease such as milk fever and the "downer cow" syndrome. Sub-clinical mineral imbalances may reduce productivity by reducing feed intake, rumen function and the activity of metabolic enzymes, or by suppressing the immune system. The first question to be discussed will be- How do I know if my herd has a mineral problem? This round table presentation will focus on the physiological factors causing these mineral disorders in order to promote a discussion of feeding and management strategies aimed at preventing these disorders. Our latest DCAD formulation strategy will be presented and opened up for critique and discussion. The causes of downer cow syndrome will be presented so as to allow discussion of preventative/treatment strategies. A brief presentation on oral administration of minerals at calving to prevent/treat these disorders will act to promote discussion of drenching as a management tool for the fresh cow.

Key Words: Milk Fever, Hypophosphatemia, Hypomagnesemia

43 Does nutrition during the far-off dry period impact transition success? J. K. Drackley* and H. M. Dann, *University of Illinois.*

Recent interest on the importance of the transition period to health and profitability of dairy cows has focused largely on diets fed during the close-up dry period (i.e., the last 2 to 3 wk before expected parturition). Much emphasis has been placed on increasing nutrient density of the diet and striving for maximal dry matter intake (DMI) during the close-up period; indeed, the National Research Council (NRC) made such recommendations in its latest (2001) publication on Nutrient Requirements of Dairy Cattle. However, several recent studies have demonstrated no advantage in subsequent milk production or frequency of health disorders to increasing nutrient density of the close-up diet. It has been our contention for several years that it is appetite and DMI in the immediate postpartal period that is critical to avoidance of many of the peripartal health disorders. Previous research from our laboratory (Grum et al., 1996; Douglas et al., 1998) and elsewhere suggested that restricted or limit feeding during the entire dry period might result in greater dry matter intakes after parturition and lower triglyceride content in liver at 1 d after parturition. In contrast, another recent study (Dann et al., 2001) showed no benefit to restricted feeding during the dry period. We have postulated previously (Drackley, 1999) that perhaps nutrition during the far-off dry period (first 5 to 6 wk of dry period) might interact with close-up nutritional management. Unfortunately, much of the current literature on effects of nutrition on transition success does not include sufficient information about how cows were fed and managed during the far-off dry period to make clear conclusions on its importance and impact. Our working hypothesis is that cows fed a bulky, low-energy diet to meet but not greatly exceed NRC recommendations is a key component of minimizing health disorders, maximizing postpartal DMI, and maximizing subsequent milk production. An experiment currently is in progress to test this hypothesis.

Key Words: Transition Cow, Dry Period, Periparturient Cow

44 The role of yeast culture in transition cow nutrition. I. Yoon*, G. M. Kamande, C. R. Belknap, M. A. Engstrom, and M. A. Kujawa, *Diamond V Mills, Inc.*

The stress and physiological changes that cows experience during the transition stage result in reduced dry matter intake (DMI), loss of body condition, and predisposing them to metabolic and reproductive disorders. Unless properly managed, this can negatively impact production and profitability. Practical strategies for maintaining adequate DMI involve: improving the environment to ease stress; balancing the ration; and nurturing a healthy rumen to maximize digestibility. A flourishing rumen microbial population can provide up to 80% of the cow's daily protein and energy requirements. Feeding fully fermented yeast culture during the transition period can support high performance by increasing lactate-utilizing and fiber-digesting bacteria. This results in higher feed digestibility and VFA production. Past *in situ* studies, using corn silage suspended in the rumens of cows, found increased degradation for dry matter, neutral detergent fiber and acid detergent fiber when yeast culture was fed. Increases in ruminal degradation were 2.2, 3.4, and 3.4% units for DM, NDF and ADF, respectively. Results from four studies with 116 transition cows showed an improvement of 1 kg DMI and 2.2 kg of 3.5% FCM over the control when cows were fed 56 g of yeast culture daily. In addition, numerous studies observed less body weight loss during 1-42 days in milk with yeast culture over the control (32.1 kg vs. 55.5 kg). Recently, scientists in Louisiana observed increased DMI and milk production when transition rations were top-dressed with yeast culture during heat stress. However, differences in efficacy of yeast-based products exist. A recent Saudi Arabian study confirmed that a fully fermented yeast culture was superior to a live-yeast product. Holstein cows on fully fermented yeast culture produced 3.1 kg more milk and 0.3% more milk fat compared to those on live yeast. It is evident that fully fermented yeast culture helps to ease dairy cow transition by enhancing microbial growth and feed intake, thereby resulting in increased milk production, and improved reproductive performance and metabolic health.

Key Words: Yeast Culture, Transition Cow, Production and Health

45 Ruminal response to diet and dry matter intake changes during the transition period. J. E. Shirley*, *Kansas State University.*

The ultimate success of a transition cow nutrition and management program is a lactation characterized by high milk and component yields and an absence of ruminal, metabolic, mammary gland, and reproductive disorders. To this end, prepartum nutritional research has focused on the development of close-up diets that encourage ruminal adaptation to subsequent lactational diets, prevent metabolic disorders, and minimize tissue mobilization prior to parturition. Some attention also has been paid to body condition at calving and fresh cow diets. The objective of our recent work was to characterize ruminal and metabolic responses to changes in diet and physiological state as the cow transitions from one lactation to another. The research was designed to provide baseline data to support future research and to clarify some issues associated with ruminal response to the currently accepted use of far-off and close-up diets during the dry period. The observed decrease in dry matter intake prior to parturition is not due to a decrease in rumen capacity but likely due to rumen function and metabolic factors. Shifts in ruminal microbial populations occur when diets are changed and as feed intake decreases or increases. End products of ruminal fermentation and dry matter digestibility are impacted by shifts in ruminal microbial populations, but the impact of these changes on cow performance requires further clarification. Ruminal microbial populations adjust to nutrient dense lactation diets shortly after parturition but continue to adapt to increased dry matter intake during the first 48 d postpartum after which passage rate decreases and dry matter digestibility improves. Further studies are needed to determine the effect of diet manipulations on rumen function during the transition period.

Key Words: Transition Period, Rumen Function, Dairy Cows

46 Feeding pre-fresh transition cows: should we maximize feed intake or minimize feed intake depression? D. G. Mashek* and R. R. Grummer, *University of Wisconsin, Madison.*

In the past decade, research has emphasized the importance of nutritional management of transition dairy cows. On average, dry matter intake (DMI) declines 30% during the last week prepartum and is one of the primary concerns of feeding transition cows. Because the decrease in DMI may lead to nutrient and energy deficiencies, maximizing DMI prior to parturition is advocated. Previous research from our laboratory has shown that force-feeding pre-fresh cows through a rumen fistula to maintain high DMI decreased liver triglyceride content and increased DMI and milk production postpartum. It is not known if force-fed cows excelled because they had greater DMI or because they did not experience the decline in DMI prior to parturition. Recent data from our laboratory suggests that preventing the decline in DMI may be more important than maximizing DMI prepartum. Perhaps efforts should be

focused on minimizing the decline in DMI the day or two prior to parturition. Studies in other laboratories have shown that limit-fed cows, or cows with low intakes, do not have as severe changes in DMI prepartum and have less liver triglyceride after parturition compared to cows with high DMI. These studies further support the concept that mean DMI may be less important than DMI change during the pre-fresh period. Additionally, other factors such as body condition and parity have been shown to influence DMI. The decrease in DMI prepartum is more severe as body condition increases. It is known that heifers have less severe declines in DMI prepartum and lower liver TG concentrations compared to cows. Perhaps the DMI patterns for heifers and obese cows influence their susceptibility to postpartum complications. This paper will explore the relationships between changes in DMI and mean DMI in the pre-fresh period with postpartum DMI, milk production, and metabolic status of dairy cows.

Key Words: Dry Matter Intake, Transition Cow, Fatty Liver

47 Rumen-stable choline for transition dairy cows.

D. E. Putnam* and J. E. Garrett, *Balchem Encapsulates*.

The objective of this summary is to review the responses to rumen-stable choline in transition dairy cows. The database of information on rumen-stable choline for transition cows is growing, and showing consistency in patterns and magnitude of responses. Effective rumen-stable technology is required to supply ruminants with choline due to near complete ruminal fermentation of dietary choline sources. The classic choline deficiency symptom across species is fatty liver; augmenting supply of choline to transition dairy cows can effectively minimize lipid infiltration of the liver under typical nutritional and management conditions. Correspondingly, indicators of glucose status and metabolism have improved with rumen-stable choline use in transition cows. A growing database of university and field level research trials is supporting a 2.5 kg/d increase in milk yield in early lactation, which a range of less than 1 to 4.5 kg/d. A recent university based trial reported a .9 kg/d improvement in pre and postpartum dry matter intake that is likely a secondary, rather than primary response to choline supplementation. Most recent research is focusing on changes in subclinical ketosis and reproduction performance with choline supplementation to transition cows. Preliminary field trials have supported improvements in both areas with small animal numbers. More research is required to substantiate the magnitude and consistency of responses in these areas. Diligence in characterizing the rumen-stability of rumen-stable choline supplements under baseline and normal feeding and handling conditions is required to gain effective responses to its supplementation. More basic research into the choline requirements of cows across stages of lactation and across animal, dietary and management conditions to allow for more dynamic nutrient recommendations will improve the application of this technology under commercial conditions. Rumen-stable choline supplementation to transition dairy cows is creating responses consistent with the biology of the nutrient and are of value to producers under commercial conditions.

Key Words: Choline, Rumen-Stable, Transition Cow

48 Measuring pork quality to educate producers and allow them to obtain value-added marketing opportunities.

M. T. See*, *North Carolina State University, Raleigh NC*.

Pork producers are aggressively pursuing value-added marketing opportunities. An extension program was developed to assist producers who are targeting products toward markets where the value attributes are antibiotic free, family-farmed, welfare friendly, or other label attributes that are not necessarily associated with muscle quality. Market hogs (n = 354) from 11 producers were evaluated for hot carcass wt, lean composition and fresh pork quality. At 24 h postmortem, midline fat depth was measured at the first rib, last rib, and last lumbar locations. The right loin from each carcass was split at the 10th rib for measurement of ultimate pH, Minolta color, drip loss, loin area, and marbling score. Loins were classified as red, firm and normal (RFN), red, soft and exudative (RSE), or PSE. Carcass composition differed by producer ($P < 0.001$) ranging in fat free lean percentage from 46.4 ± 1.2 to 56.0 ± 1.1. In addition, loins from different producers significantly differed in all quality measures. Across producer, loin drip loss percentage ranged from 2.03 ± .44 to 5.53 ± .54 ($P < 0.001$), Minolta L* value ranged from 51.7 ± .7 to 58.9 ± 1.1 ($P < 0.001$), ultimate pH ranged from 5.66 ± .03 to 6.19 ± .03 ($P< 0.001$), and marbling score ranged from 1.3 ± .3 to 2.3 ± .2 ($P < 0.001$). Chi-square analysis and Cochran-Mantel-Haenszel statistics were used to test differences in pork quality classification across producer. Pork quality classification differed by producer ($P < 0.01$) ranging from 100% RFN to 56.8% RFN, 13.6% RSE and 29.6% PSE. These results were shared with producers during an educational program that described quality measures, presented individual results, and described methods to improve quality at the farm level. Producers were able to learn recommended production practices and share knowledge among their peer group. In addition, a 17-step assessment program was developed to evaluate and improve farm level control points that impact fresh pork quality. Assessment programs were also developed for six other value-added attributes. This program has helped pork producers improve pork quality, gain entry into value-added markets, and secure repeat sales.

Key Words: Extension, Pork, Quality

49 Using heart girth to estimate weight in finishing pigs.

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Heart girth (HG) and body weight (BW) were measured on 100 growing-finishing pigs (22.8 to 123.8 kg) at the KSU Swine Teaching and Research Center. Heart girth was measured using a cloth measuring tape. The tape was placed directly behind the front legs and then wrapped around the pig and read directly behind the shoulders. A regression equation was developed to predict pig BW from the HG measurement (pig weight kg = 10.1709 x Heart girth, cm -205.7492). Heart girth was strongly correlated (r2= .98) with BW, with a 95% confidence interval of 4.5 kg. To validate our equation, we weighed and measured HG on 40 and 58 pigs from two commercial farms, and a group of 165 pigs at the 2002 KS Swine Classic Youth Exposition. At the first commercial farm, the actual measured pig BW fit within the 95% confidence interval from their predicted BW in all cases. The average residual (difference between predicted and actual BW) of the 40 pigs was -0.32 kg with a range of 1.8 kg. The 58 pigs from the second commercial farm also all were within the 95% confidence interval of their projected weights. The average residual of the 58 pigs was -0.41 kg with a range of 1.4 kg. The actual BW of pigs at the Swine Classic averaged 7.3 kg greater than their predicted BW with a range of 3.9 kg. The actual weights failed to fall within the 95% confidence interval for the developed regression equation. This was probably due to weight loss during transportation to the show and limited feed and water, as all pigs were weighed within approximately 1 h of arrival. Using HG to estimate pig weight can be very useful for 4-Hers and swine producers. However, it is important to emphasize the need for accuracy of the HG measurement. Based on our equation, every 2.54 cm the HG is under- or over-estimated, estimated pig BW will be off by 4.5 kg. Averaging several HG measurements from individual pigs should more accurately predict BW. In addition, pigs should not be measured when withheld from feed or water to insure accuracy of results.

Key Words: Heart Girth, Finishing Pigs, Swine

50 Development of a stochastic pig compositional growth model.

A. P. Schinckel*, N. Li, P. V. Preckel, M. E. Einstein, and D. Miller, *Purdue University, West Lafayette, IN*.

A stochastic pig compositional growth model was developed using mixed model nonlinear functions. Serial body weight (BW) measurements were fitted to mixed model nonlinear equations with three parameters and two random effects. The best model for BW based on Akaike's Information Criteria (AIC) values was $BW_{it} = (C + c_i)$ (1 x exp (-exp (M' + m'_i) t^A)) + birth weight + e_{it}, where C, M', and A are fixed population mean parameters; c_i and m'_i are random effects for the i^{th} pig; t is days of age; birth weight is a constant (1.4 kg); and e_{it} is the residual error. Empty body protein mass (EBPRO) data were predicted from serial real-time ultrasound and BW measurements. Predicted EBPRO data were fit to a nonlinear function of BW with one random effect: EBPRO = C $(f(BW))$ + cp_i $(f(BW))^D$, where $f(BW)$ = (1 x exp (b_0 + b_1 BW + b_2 $(BW)^2$), C and D are fixed parameters, and cp_i is a random effect. The value of D, 1.895 (SE = 0.09) indicates the between pig variation of empty body protein mass percentage increases as empty body protein or BW increase. The model accounts for the relationship among the random effects for BW growth and cp_i. Daily lipid accretion was predicted from genetic population-sex specific relationships between BW, EBPRO, and empty body lipid mass: empty body weight = 0.93

BW; and empty body weight = a_1 (EBPRO)$^{b}1$ + a_2 (empty body lipid mass)$^{b}2$. The model predicts a pig specific BW growth curve and daily compositional growth rate for carcass fat-free lean, carcass fat tissue, EBPRO, and empty body lipid. Carcass measurements were predicted as functions of carcass weight, fat-free lean or carcass fat tissue mass, sex, and carcass fat-free lean or fat tissue percentage. To reproduce the total variation in compositional growth, the residual variance of each variable was produced by multiplying the residual standard deviation of each prediction equation by a value sampled from a standard normal distribution. The stochastic model can be used to develop strategies to target a specified mean and distribution of carcass weight and composition.

Key Words: Pig, Stochastic, Growth Model

51 Economic evaluation of feeding pigs on ractopamine step-up programs of two durations. N. Li*, A. P. Schinckel, P. V. Preckel, K. A. Foster, and B. T. Richert, *Purdue University, West Lafayette, IN USA*.

Two ractopamine (RAC) step-up programs (5 to 7.5 ppm and 5 to 10 ppm) were evaluated for their economic returns using a swine growth simulation program which incorporated growth responses to constant RAC concentrations and step-up RAC programs. Dietary lysine concentrations were optimized to achieve maximum daily returns. Two durations of RAC feeding were evaluated for both step-up programs: 28 or 35 d, where 5 ppm was fed either for 14 d or 17 d and followed by either 7.5 or 10 ppm RAC for another 14 or 18 d, respectively. The initial BW of pigs fed RAC was set at 78 and 72 kg for the 28 and 35 d feeding durations, respectively. Three diets were fed: the first before RAC supplementation, the second with the 5 ppm RAC, and the third with the step-up RAC concentration. Pigs on constant RAC concentrations (5 and 10 ppm) and pigs fed 0 ppm RAC were also simulated with three diets (i.e., lysine concentrations), where RAC and the diet starting day were the same as those in step-up programs, and control pigs were grown to the same BW as RAC-fed pigs. Two payment schemes were used: one set the lean to fat price ratio at 4:1, close to true carcass cut-out value, and the other set the lean to fat price ratio to 2:1, approximating carcass merit pricing systems. Returns were estimated with ten year (1991-2000) average prices and production costs. The simulation results indicated that 5 to 10 ppm step-up had the highest daily returns, followed by 5 to 7.5 ppm step-up, constant RAC feeding, and the control. The step-up programs had an average of \$4.6 and \$6.6 higher returns per pig than control and \$1.6 and \$2.3 higher returns per pig over constant RAC concentrations when the lean to fat value ratios were 2:1 and 4:1, respectively. The optimal dietary lysine percentages in the third diet of the step-up programs were 0.10 to 0.16 percentage units higher than those with constant RAC concentrations. Under average economic conditions, step-up programs were predicted to be more profitable than feeding constant dietary RAC concentrations.

Key Words: Pig, Ractopamine Step-Up Program, Economic Analysis

52 Economic evaluation of ractopamine at selected dietary concentrations for finishing pigs. N. Li*, A. P. Schinckel, P. V. Preckel, K. A. Foster, and B. T. Richert, *Purdue University, West Lafayette, IN USA*.

The economic returns of ractopamine (RAC, Paylean®) was evaluated using a model that simulated the daily growth of finishing pigs fed with or without RAC. The pig's start weight on RAC, duration of RAC feeding, and the dietary lysine levels were set to economically optimal values to maximize the daily returns from 23 kg BW to finished market BW. Four concentrations of RAC (0, 5, 10 and 20 ppm) were evaluated. Two production scenarios were simulated: one restricted the pigs to be marketed at a maximum BW of 110 kg and the other allowed pigs to grow to obtain the highest average daily return. In addition, two dietary lysine phase-feeding options were evaluated: 2 or 3 diets from 104 d of age to market age, each with one diet before RAC was fed. Four payment schemes were used to describe the various market systems and differences in lean to fat value, ranging from carcass weight pricing to a 4:1 lean to fat price ratio that simulated the true cut-out value of the animal. Ten year average input and output prices, and production costs were used in the analysis. Comparing RAC-fed pigs and controls in either restricted or unrestricted with the 110 kg BW limit, feeding RAC was profitable under each payment scheme. The highest returns were for either pigs fed 5 or 10 ppm RAC, whose net return over controls ranged from \$1.36 to \$5.78 per pig, depending on the presence of the market BW restriction and payment scheme. However, if RAC-fed pigs were restricted with the market BW limit and control pigs were allowed to grow to their optimal market BW, then RAC feeding was only profitable when pigs were marketed on a carcass merit payment system or when lean was given a higher value than fat tissue. The market BW restriction decreased returns by approximately \$1.64 per pig. Feeding two diets containing RAC instead of one diet increased returns by \$0.40 per pig and increased the RAC feeding period by an average of 2.6 days. The optimal lysine percentages for pigs fed RAC were from 0.17 to 0.49 percentage units higher than for the control pigs, depending on dietary RAC concentration and payment scheme.

Key Words: Pigs, Ractopamine, Economic Analysis

53 Optimizing ractopamine concentration and duration in pork production. N. Li*, A. P. Schinckel, P. V. Preckel, K. A. Foster, and B. T. Richert, *Purdue University, West Lafayette, IN USA*.

A mathematical simulation model was developed to quantitatively describe the compositional growth performances of pigs fed 0 to 20 ppm ractopamine (RAC). The program, written in GAMS, can identify the economically optimal RAC concentration, its duration and dietary lysine percentages, which together yield the highest daily return. Daily returns from 23 kg to market BW were estimated and maximized with ten year average prices and production costs. Four payment schemes were used: (1) carcass weight; (2) predicted percent lean; (3) lean to fat price ratio of 2:1; and (4) lean to fat price ratio of 4:1. All payment schemes had discounts on under- and over-weight carcasses. Two types of phase-feeding were simulated: two or three diets for pigs from 104 d of age to market age, with one or two diets containing RAC, respectively. The model incorporated FDA's restrictions for RAC concentration (5 to 20 ppm) and BW of RAC feeding (68 to 110 kg). The optimal RAC concentrations ranged from 5 to 10.5 ppm and increased as the ratio of lean to fat values increased. The 3-diet management had a higher return of \$0.50 per pig than the 2-diet feeding program and resulted in a 6-d longer RAC feeding period. Payment scheme 4 had a longer optimal RAC feeding time (4 to 8 d) under the 2 diet management but no difference in duration of RAC feeding with the 3 diet management.

Table 1: Return and optimal RAC concentration and duration for finishing pigs

Payment scheme	**1**	**1**	**2**	**2**	**3**	**3**	**4**	**4**
Sex	**G**	**B**	**G**	**B**	**G**	**B**	**G**	**B**
2 diet management								
RAC, ppm	5.0	5.0	5.0	8.0	7.5	7.0	10.0	9.0
RAC start wt., kg	77.8	79.1	77.8	74.8	74.7	74.8	70.6	70.6
Days on RAC	28	26	28	30	31	30	35	34
Return, \$/pig space/d	0.280	0.285	0.304	0.305	0.314	0.301	0.347	0.314
Profit over ctrl, \$/pig	1.56	1.35	3.87	3.52	3.55	3.35	5.51	5.04
3 diet management								
RAC, ppm	5.0	5.0	5.0	6.5	6.5	6.5	10.5	9.0
RAC start wt., kg	70.6	70.5	70.6	69.5	70.6	70.6	69.6	70.6
Days on RAC	35	34	35	34	35	34	35	34
Return, \$/pig space/d	0.285	0.290	0.309	0.309	0.320	0.307	0.353	0.320
Profit over ctrl, \$/pig	1.95	1.72	4.25	3.78	4.04	3.88	5.95	5.56

G = Gilt, B = Barrow.

Key Words: Ractopamine, Pig Growth Model, Economic Analysis

54 Accuracy of Prediction in the National Swine Improvement Federation (NSIF) Ultrasound Certification Program. C. R. Schwab*[1], T. J. Baas[1], S. J. Moeller[2], and D. W. Newcom[1], [1]*Iowa State University, Ames, IA,* [2]*The Ohio State University, Columbus, OH.*

Real-time ultrasound technology is commonly used to provide an accurate, inexpensive, and non-invasive method for the assessment of backfat and loin muscle area in live swine. Accurate measurements are essential to facilitate genetic progress in these traits. This study compiled results from the 1998-2002 NSIF Ultrasound Certification Programs to illustrate how different levels of body composition affect the accuracy of 10^{th} rib loin muscle area (LMA) and off-midline backfat (BF10) measured on the live animal. The NSIF Certification procedure assesses a technician's ability to accurately estimate carcass measurements, bias, and repeatability of live ultrasonic scans taken on 50 pigs. Standard Error of Prediction (SEP) is used as a measure of accuracy, while the Standard Error of the Difference (SED) is calculated as repeatability. Bias is the average difference between live and carcass measurements. After scanning, pigs were harvested at a commercial facility and carcass data were collected by trained personnel. A total of 103 technicians were evaluated and 46 were granted certification for both BF10 and LMA over the five year period. Results were compiled to compare SEP, SED and bias among three certification classifications and three levels of BF10 and LMA. Certified technicians were more accurate in predicting pigs with LMA < 38.7 cm^2 (SEP $= 2.37$) when compared to pigs with a carcass LMA > 45.2 cm^2 (SEP $= 2.97$). Pigs with BF10 < 1.8 cm were more accurately predicted (SEP $= 0.18$) by certified technicians, compared to pigs with BF10 > 2.5 cm (SEP $= 0.43$). Technicians tended to underestimate LMA on pigs with > 45.2 cm^2 and BF10 on pigs with $>$ 2.5 cm. However, technicians overestimated LMA on pigs with < 38.7 cm^2 and on pigs with BF10 measurements < 1.8 cm. SED values were lower for pigs with carcass LMA measurements < 38.7 cm^2 and BF10 measures < 1.8 cm. Results show that the magnitude of BF10 and LMA measurements influence the accuracy of prediction with ultrasound.

Key Words: Swine, Ultrasound, Certification

55 Educational needs of Nebraska Pork Producers and Employees. D. E. Reese*, A. L. Prosch, S. S. Blodgett, and S. K. Rockwell, *University of Nebraska.*

An August, 2002 mail survey to 2,739 Nebraskans who completed Pork Quality Assurance training determined educational needs and preferred information resources for Nebraska pork producers and employees. Completed surveys were returned by 660 and incomplete surveys were returned by 406 for a total return rate of 39%. Of the completed surveys, 506 were producers (77%) and 154 (23%) were employees. The Nebraska Agricultural Statistics Service estimated that 1,300 producers held 91% of Nebraska's hog inventory in December 2001. Chi-square analyses evaluated differences between producers and employees. Results indicate that 78% of the producers and 80% of the employees intend to remain in production for the next five years. Sixty percent were between 34 and 54 years of age; 20% were younger than 34 and 20% were older than 54. As expected, respondents indicated more change is needed in the marketing, finance, and business aspects of the pork enterprise in the next five years than in health, housing, genetics, nutrition, reproduction, or environment. The most preferred future information resources were magazine/newsletter, Internet, and seminar/workshop. The least valuable future information resources were CD-ROM, video tape, and videoconferencing. As expected, the Internet will be a more important resource in the future. Sixty-nine percent of the respondents have access to the Internet and 75% of those use it at least weekly. More employees rated seminars/workshops as a primary future information resource than producers ($P < 0.01$). As expected, producers indicated a greater need for training in business management than employees ($P < 0.03$). Employees expressed greater needs for training in facility management, nutrition, disease management, pig care and management, animal welfare, antibiotic usage, odor control techniques, goal setting, and human resource management than producers ($P < 0.03$). These results indicate that for pork producers, educational needs in business management will increase and that producer and employee-specific educational programs are warranted.

Key Words: Pigs, Education

56 Evaluation of a salve or two novel winter teat dips to maintain or enhance teat end integrity during winter. D. Paulsen*, L.L. Timms, and M.A. Faust, *Iowa State University.*

Three separate trials embedded in a 3 year longitudinal observational study were conducted to evaluate the performance of a salve or 2 novel winter teat dips to maintain or enhance teat end health and integrity compared to an effective (germicide and skin conditioning)commercial post milking teat dip and practices used in this herd. Trained observers evaluated all teats of all lactating cows at the Iowa State Dairy every 2 (trial 3) or 3 days (trials 1 and 2)using a 5 point scoring system (.5 increments). A score of 1 was a normal teat end with no evidence of hyperkeratosis or cracking. Scores of 1.5 and 3.5, 2 and 4, 2.5 and 4.5, and 3 and 5 showed minor, mild, moderate, or severe hyperkeratosis, respectively, with scores above 3.5 showing some cracking at the teat end, also. All trials used a split udder design where right side teats received the usual herd postmilking teat dip (.55 % chlorhexidine with 8% skin conditioners) and served as controls. Left side teats received either a salve or novel winter teat dip post milking. In trial one, left teats of 160 cows were treated with a germicidal (.5 chloroxynol) salve containing aloe extract, lanolin, and glycerin for 6 weeks (12/96-1/97). During trial 2, left teats of 182 cows were treated with a commercial winter teat dip containing $> 70\%$ skin conditioners (propylene glycol)and germicidal fatty acids for 8 weeks(1/97-3/97). During trial 3, left teats of 212 cows were dipped with a different glycol based (>70%) commercial winter dip for 5 months from 10/97-3/98. There were no significant differences in teat end scores for all days or overall between treated and control teats in trials 1(2.36 vs 2.31) and 2 (2.20 vs 2.21). There were significant changes in teat end scores over time probably due to weather, but changes were similar for control and treated teats. Teats dipped with a glycol based dip scored significantly lower than controls overall (2.71 vs 2.77, p=0.0008)in trial 3. Results from these trials showed no or very small positive effect on teat end health for salves and glycol winter dips compared to a very good commercial post milking dip and good dipping practices. None of the treatments were effective in completely alleviating teat changes due to weather conditions.

Key Words: Salve, Teat Dips, Winter

57 Characterization of the growth and development of replacement dairy heifers on west-central Missouri dairy farms. J.C. Coomer, R.C. Bennett, and R. Randle, *The University of Missouri Extension.*

This project was started in the spring of 2000 with eight farms initially participating. The objective of the project was to characterize the growth and development of replacement dairy heifers on Missouri dairy farms by weighing, measuring height and recording a body condition score on heifers on a regular basis over a period of time on multiple farms. Since the initiation of the project two farms have stopped participating in the project and four new herds have started participating in the project. It was also an objective to get industry participation in this project and we have feed company representatives participating in data collection and performance monitoring on three of the farms currently participating in the project. Data from the project show that the weight of the heifers has averaged at or just below the desired weight for all ages of heifers as compared to the Penn. State heifer growth charts for Holsteins. All but a very few of the heifers in the project are Holstein and those few are Holstein cross bred. However, the heifers heights have been in the middle of the desired range for all ages when compared to the growth charts. Heifer ADG has not differed by season (0.69, 0.73, 0.73, and 0.72 kg/d for winter, spring, summer, and fall respectivly, SD 0.33) as we had expected but is below the desired rate of gain (0.84 kg/d) to achieve first freshening at 24 months of age and weighing 600+ kg. This is supported by the fact that the average age of heifers that have freshened since the project began is 27.4 months. Despite this delay in first freshening the heifers are freshening with an estimated weight at first freshening of 582 kg. However, this weight does appear to be increasing slightly each year (571, 586, 590 kg for 2000, 2001 and 2002 respectivly). It is our goal to use the information we have collected and continue to collect to help these and all Missouri dairy heifer growers improve thier heifer raising programs.

Key Words: Dairy Heifers, Growth, Holstein

58 Developing educational strategies that add value to replacement beef heifers: The Missouri Show-Me-Select Replacement Heifer Program. D. J. Patterson*, R. F. Randle, J. L. Parcell, M. F. Smith, M. S. Kerley, K. C. Olson, and J. Z. March, *University of Missouri, Columbia*.

The Missouri Show-Me-Select Replacement Heifer Program was designed to improve reproductive efficiency of beef cow herds in Missouri and increase individual farm income. The program objectives include: 1) a total quality management approach for health and management of heifers from weaning to late gestation; 2) increased marketing opportunities for and added value to Missouri raised heifers; and 3) the creation of reliable sources of quality commercial and purebred replacement females. The program was initiated as a pilot project in two regions of Missouri in 1997 with 33 farms and 1,873 heifers. Over the past 6 years, 440 farms enrolled 43,946 heifers in the program. Regional extension livestock specialists serve as coordinators of the program locally and work closely with the 156 veterinarians involved with the program state wide. State specialists provide program support to regional extension field staff and participating veterinarians. The reproductive goals for heifers enrolled in the program are aimed at improving breeding performance during the heifers first breeding period, minimizing the incidence and severity of dystocia that heifers experience with the resulting delivery of healthy vigorous calves, and successful rebreeding of heifers during the subsequent breeding season. The marketing component of the program facilitated the sale of 8,017 heifers in 34 sales across Missouri from 1997 through the spring sales in 2002. These sales generated interest from 2,606 perspective buyers that formally registered to buy heifers, and 983 individuals that purchased heifers from the various sales. Heifers from the program have now sold to farms in AR, AZ, IA, IL, IN, KY, KS, MO, OK, and TN. Collectively, 34 sales have generated 7,320,832 dollars in gross sales. The Missouri Show-Me-Select Replacement Heifer Program is the first statewide on-farm development and marketing program of its kind in the U.S.

Key Words: Beef Heifer Development, Reproduction, Marketing

59 Relationship of electrical power quality to milk production of dairy herds. D. Hillman*[1], D. Stetzer[2], M. Graham[3], C. L. Goeke[1], K. Matson[2], H. H. VanHorn[4], and C. J. Wilcox[4], [1]*Michigan State University, E. Lansing,* [2]*Stetzer Electric, Blair, WI,* [3]*U. California, Berkeley,* [4]*U. Florida, Gainesville*.

Public Utility Commissions in several states adopted 0.5 volt or 1.0 milliampere as the actionable limit for utilities to respond to complaints of uncontrolled voltage. Dairy farmer complaints that animal behavior and milk production were affected by electrical shocks below the adopted standards were investigated on 12 dairy farms in Wisconsin, Michigan, and Minnesota. Milk production per cow was from daily tank-weight pickup. Number of transient events, transients, voltage (peak-to-peak), waveform phase angle degree, sags and sag-Vrms (voltage root mean square) were measured from event recorders plugged into milk house wall outlets. Data from 1705 cows and 939 data points were analyzed by multi-herd least-squares multiple regression and SAS-ANOVA statistical programs at the University of Florida. In five herds for 515 days, milk/cow/day decreased -0.063 lb./transient event as transient events increased from 0 to 122/day ($P<0.02$). Negative effects on milk/cow/day from event recorder measurements were significant for eight independent electrical variables. Step-potential voltage and frequency of earth currents were measured by oscilloscope from metal plates grouted into the floor of milking stalls. Milk decreased as number of 3rd, 5th, 7th, 21st, 28th, 42nd, and the sum of triplen harmonics (3rd, 9th, 15th, 21st, 27th, 33rd, and 39th) increased/day ($P<0.003$). Event recorder transient events were positively correlated with oscilloscope average Vp event readings, with number of measures over 90 hertz, and number of 4th, 7th, 10th, and 42nd harmonics per day. Steps/minute from videotapes were correlated with non-sinusoidal 5.3 to 12.8 mVp impulses recorded simultaneously from EKG patches on legs. PUC standards and use of 500 ohm resistors in test circuits, underestimate effects of non-sinusoidal, higher frequency voltage/current on rural power lines.

Key Words: Transients, Harmonics, Voltage

60 NC Bovine Reproduction Task Force overview. J. R. Pursley*[1] and P. M. Fricke[2], [1]*Michigan State University,* [2]*University of Wisconsin-Madison*.

The North Central Bovine Reproduction Task Force was formed by a group of extension reproductive physiologists and formalized by the NCR ANR Program Leaders Group in 2000 to develop and deliver quality extension programming in the area of bovine reproduction. The mission is "to provide leadership and consistency of programming to dairy and beef industries in the area of reproductive physiology through Cooperative Extension efforts in the Upper Midwest." The objectives are to: 1) evaluate current methods for managing reproduction and to identify most profitable management strategies, 2) discuss, evaluate, and develop methods for delivery of Extension programs, 3) unify current and future recommendations delivered to industry, 4) discuss the implications of current research data as they relate to reproductive management of cattle, and 5) design and implement future independent and collaborative applied research projects (in conjunction with the NC-1006 Regional Research Project) to provide data necessary for making effective recommendations. Accomplishments include workshops in Michigan in 2001 and Kansas in 2002, aimed at educating veterinarians and members of the pharmaceutical and AI industries about synchronization strategies in dairy and beef cattle. This group has taken a leadership role in development of two symposia at Midwest ADSA/ASAS annual meetings. Also, several members of this group received a USDA-IFAFS grant entitled "Enhancing Management and Profitability of Small and Mid-Sized Dairy Farms" funded from 2001-2005. Original members included: Paul Fricke (Wisconsin), Darrel J. Kesler (Illinois), David Patterson (Missouri), Richard Pursley (Michigan), Leo Timms (Iowa), Dick Wallace (Illinois), and Milo Wiltbank (Wisconsin). Since then, Sandy Johnson (Kansas), Grant Frazer (Ohio), and Rick Funston (Nebraska) have joined the group. David Morris currently serves as USDA-CSREES advisor and Kim Cassel from South Dakota serves as administrative advisor.

Key Words: Reproduction, Extension, Bovine

61 A Review of the Estrous cycle in cattle: Physiology, Endocrinology, and Follicular waves. F. N. Kojima*, *University of Missouri, Columbia*.

Reproductive management and artificial insemination (AI) are important components of any successful dairy operation. These practices require a thorough understanding of the changes in physiology and endocrinology that occur during the estrous cycle of dairy cows and heifers. This review will cover the basic physiology and endocrinology of the estrous cycle in cattle, and provide an overview of our current understanding of ovarian follicular waves. Topics to be covered that specifically address basic physiology and endocrinology of the estrous cycle will include: 1) follicular development; 2) endocrinology associated with follicular development; 3) corpus luteum development and regression; 4) endocrinology associated with corpus luteum function; and 5) a summary of the estrous cycle. This review will also include an overview of prostaglandin $F_{2\alpha}$, GnRH, estradiol cypionate (ECP), and progestins in terms of their applications in estrus and/or ovulation synchronization protocols. A better understanding of physiology and endocrinology of the estrous cycle will improve reproductive management of dairy cattle and facilitate the successful application of AI, including fixed-time AI protocols.

Key Words: Estrous Cycle, Dairy Cattle

62 Fine tuning Ovsynch to improve synchronization rates and fertility. J. R. Pursley*, *Michigan State University*.

Ovsynch has become a powerful tool to control time of 1st and subsequent inseminations in lactating dairy cows. Much of the synchronization data published in recent years focuses on fine tuning Ovsynch to improve synchronization and conception rates. The original Ovsynch protocol consists of an initial injection of GnRH to induce ovulation of an existing dominant follicle (DF) and initiate a new follicular wave. $PGF_{2\alpha}$ is administered 7 d later to regress corpora lutea prior to follicle turnover. A second injection of GnRH is administered two d later to induce ovulation of a new DF. In synchronized cows, ovulation occurs between 24 and 32 h following the last injection of GnRH. Ovsynch gives producers the opportunity to AI all cows during the first week following voluntary waiting period. Ovsynch allows for similar conception rates compared to AI following a detected estrus and substantially increases

numbers of cows pregnant by 100 days in lactation. This paper will discuss the flexibility of each hormonal injection, the flexibility in the timing of AI following the last injection of GnRH, and how changes in each of these events may impact synchronization and conception rates. Effects of pre-synchronization injections of $PGF_{2\alpha}$, GnRH, and bST will be discussed in addition to using Ovsynch as a model to test ways to improve other reproductive inefficiencies.

Key Words: Ovsynch, Timed-AI, GnRH

63 Systems for early identification of nonpregnancy and resynchronization of ovulation in dairy cattle. P. M. Fricke*, *University of Wisconsin-Madison*.

Hormonal synchronization protocols that allow for successful fixed-time AI in lactating dairy cows have provided an effective tool for increasing submission rate for first AI service. Because average conception rates of high-producing lactating dairy cows are reported to be 40% or less, 60% or more of cows receiving first AI service will fail to conceive. Early identification of nonpregnant cows can improve reproductive efficiency and pregnancy rate by decreasing the interval between AI services and increasing AI service rate. Several new and existing technologies have been developed for detecting nonpregnancy in dairy cattle. The Early Conception Factor (ECF) test reportedly detects a pregnancy-associated glycoprotein within 48 h of conception. However, we estimated the predictive value of a negative ECF test result to be less than 50% (i.e., no better than a guess) in dairy herds exhibiting a conception rate greater than 25%. By contrast, transrectal ultrasonography can be used to diagnose nonpregnancy at 26 to 28 d post-AI with a high degree of diagnostic accuracy. One caveat of any method for early pregnancy diagnosis is that cows diagnosed pregnant early post AI are at risk for experiencing early embryonic loss and, therefore, must undergo subsequent pregnancy rechecks to identify and rebreed cows that experience embryonic loss. Once a method for early identification of nonpregnancy is implemented, a nonpregnancy diagnosis must be coupled with a management strategy to return cows to AI service. Several resynchronization systems that use transrectal ultrasonography to detect nonpregnancy and Ovsynch to resynchronize ovulation have recently been tested. Strategies using CIDR devices inserted and removed post-AI to resynchronize estrus and cowside milk progesterone tests to identify and rebreed nonpregnant cows post-AI also have been tested. Development of integrated reproductive management systems that combine early identification of nonpregnancy with a strategy to rapidly and return cows to AI service may further improve reproductive efficiency in lactating dairy cows.

Key Words: Resynchronization, Timed AI, Ultrasound

64 Utility of CIDRs in improving reproductive performance and management of dairy cows. D.J. Kesler* and T.L. Steckler, *University of Illinois*.

The CIDR, an intravaginal progesterone insert (IPI), was approved by the FDA in 2002. Although FDA approved the use of the CIDR for synchronization of estrus in dairy and beef heifers and beef cows, advancement of the first pubertal estrus in beef heifers, and advancement of the first postpartum estrus in beef cows, it has several additional applications including estrus synchronization of dairy cows. The approved protocol includes the injection of PGF six days after CIDR insertion and CIDR removal the next day; however, this may not be the protocol with maximal efficacy. Other applications evaluated include: 1) inclusion with Ovsynch for synchronization of heifers and cows, 2) inclusion with Ovsynch for preparing ET recipient cows, 3) inclusion with Ovsynch for treatment of cystic ovarian disease, 4) treatment after insemination to enhance the establishment of that pregnancy, and 5) treatment for synchronization of the return estrus of cows not conceiving to the first synchronization protocol. When the IPI was included with Ovsynch, inserted at the first GnRH injection and removed at the PGF injection seven days later, it has been demonstrated to improve pregnancy rates in anestrous dairy cows (20 more pregnancies per 100) and all cows combined (15 more pregnancies per 100). The IPI improved pregnancy rates in ET recipient cows when it was included with Ovsynch. There were 10 more pregnancies per 100 cows treated with the Ovsynch protocol that included the IPI. Overall, 94% of the cows starting the protocol received embryos and 64% became pregnant. When the IPI was used with the Ovsynch protocol 100% of the cystic cows ovulated and 44% became pregnant at the timed AI subsequent to treatments. When the IPI was administered on day 7 post-breeding through day 14 it either improved (one study had 12 more pregnancies per 100) or have no effect (other studies) on pregnancy rate to the previous breeding. Studies have demonstrated that nonpregnant cows administered the CIDR about 14 to 21 days after breeding express a shorter period of return estrus than untreated cows. In summary, the CIDR/IPI has many applications to improve pregnancy rates in dairy cows and facilitate reproductive management.

Key Words: CIDR, Synchronization, Embryo Transfer

65 Monitoring reproductive performance: Tools and rules. R. L. Wallace*, *University of Illinois*.

The reproductive management of dairy herds has a sizeable impact on the productivity and profitability of those operations. Reproductive inefficiency results in excessively long lactations where milk production progressively declines or prolonged non-productive periods (long dry periods). Both results are costly to the dairy producer, but a long-term effect may be inadequate numbers of replacement heifers to maintain stable herd size. Purchased replacements increase the risk that new diseases will be introduced on the dairy operation, which may have even greater and more long-lasting impact on the productivity and profitability.

Reproductive failure accounts for 20-25% of the reason dairy cows are marketed for beef. Abortions may contribute to this figure, yet on average, less than 3% of cows abort each year (NAHMS Dairy 96). Infertility precludes the option of removing animals from the herd because they are inefficient milk producers. Not all reproductive cull cows are sold because they are infertile. Often cows have not been offered an adequate opportunity to express their ability to reproduce. Successful reproduction is a combination of the assigned length of the voluntary waiting period (VWP), the proportion of cows bred due to detected heat or timed insemination (service rate), and the proportion of cows that conceive and carry a calf to term (conception rate). The pregnancy rate can then be defined as the proportion of cows presented for breeding that conceive (service rate times the conception rate). The 21-day pregnancy rate evaluates this parameter over selected 21 day intervals.

Monitoring dairy herd reproductive programs involves analysis of herd-average parameters such as days in milk, days to first breeding, days open, length of the dry period, calving interval and age at first calving. Consultants to dairy operations can use benchmarks for each of these parameters, but the affects of statistical bias and data momentum must be considered. Newer software programs can provide more contemporary reproductive analysis using 21-day pregnancy rates and statistical process control. These analyses can provide information so producers can make decisions to affect positive change instead of reacting to past problems from historical data.

Key Words: Reproduction, Monitoring, Pregnancy Rate

66 Dietary supplemental b-vitamins for lactating dairy cows. R. D. Shaver* and E. C. Schwab, *Univ. of Wisconsin, Madison*.

Early research showed that b-vitamins (BVIT) are synthesized ruminally; amounts and relative proportions vary depending on diet. Current dogma suggests that BVIT supply from microbial synthesis is adequate to meet animal requirements. However, BVIT duodenal flow studies are lacking and BVIT requirements are not well defined (NRC, 2001). Also, recent trials have shown efficacy from dietary BVIT addition. Thiamin (150-300 mg/d) increased milk and component yields by cows fed low NDF - high NFC diets (Shaver and Bal, JDS, 2000). Folic acid (1.3-2.5 g/d) increased milk yield by multiparous but not primiparous cows (Girard and Matte, JDS, 1998). The NRC (2001) does not recommend niacin since research trial results are highly variable. Biotin (20 mg/d) improved hoof health and DHI-estimated milk yield (Midla et al., JDS, 1998). Milk yield increased linearly with 0, 10, and 20 mg/d biotin supplemented from 14 d prepartum through 100 d postpartum (Zimmerly and Weiss, JDS, 2001). In a Latin Square trial with 28-d periods, biotin (20 mg/d) increased DMI and milk yield (Majee et al., JDS abstr., 2002). Biotin efficacy in short-term trials (Zimmerly and Weiss, JDS, 2001; Majee et al., JDS abstr., 2002) suggests that biotin improves milk yield directly via effects on intake, digestion, and (or) metabolism rather than indirectly via improved hoof health. Majee et al. (JDS abstr., 2002) reported that a BVIT blend was not beneficial over biotin added alone. Further, there was no benefit to adding

biotin at 40 versus 20 mg/d. Zinn et al. (JAS, 1987) measured duodenal flows of several BVIT, and reported extensive ruminal microbial degradation of supplemental BVIT with lower degradation for biotin and B6. These observations regarding microbial degradation may partially explain the variable responses to supplemental ruminally-unprotected BVIT reported in the literature and the more consistent efficacy reports for supplemental unprotected biotin. Extensive microbial degradation of some supplemental BVIT suggests a role for ruminally-protected BVIT to improve efficacy, consistency of response, and (or) reduce minimum effective dosages. Ruminally-protected choline is available commercially.

Key Words: B-vitamins, Dairy Cattle, Biotin

67 Formulating dairy rations for concentrations of fat versus fatty acids. M. L. Eastridge* and C. V. Ribeiro, *The Ohio State University, Columbus*.

Fat sources have been traditionally fed to dairy cows to increase energy intake, primarily for supporting high milk yields. The energy concentration of the fat source is dependent on concentration of fat in the source and the digestibility of the fatty acids (FA). The digestibility may be affected by FA profile of the fat source, concentration of glycerides versus free FA, and physical nature (form or size) of the fat source. Factors such as DM intake (discount factors for multiples of maintenance) and FA intake also affect digestibility of the fat source. In the NRC (2001), TDN at 1X maintenance for fat supplements was determined by indirect calculation of the partial digestion coefficient for FA by difference. Since most of the studies were conducted with cows consuming energy above maintenance, the digestibility coefficient for TDN at 1X maintenance was calculated using the FA digestibility at 3X maintenance divided by 0.92. The absorption of total FA is the primary focus for energy availability from the fat source. However, with the continued emphasis on increasing certain FA in milk, especially conjugated linoleic acid (CLA) and polyunsaturated FA, and the recent evidence of the relationship of linoleic acid and omega-3 FA with reproduction, the focus changes to selection of fat sources that can optimize the absorption of selected FA for transfer to milk or for their affect on metabolism, independent of their potential energy contribution. In the case of CLA in milk, the focus is not only on the CLA flow to the duodenum and its transfer to milk but also on absorption of *t*-11 $C_{18:1}$ that can be transformed to CLA by mammary tissue. With this additional area of focus on feeding of fat for specific FA, consideration needs to be given to the FA profile of the fat source to add to diets, the costs of the fat source relative to the energy contribution versus the absorption of the desired FA, and consideration to the selection of a fat source based on the lactational phase of the cows. These strategies must be accomplished without adversely affecting ruminal fermentation and DM intake. These aspects will be discussed in relation to the fate of FA in the rumen, FA flow to the duodenum, and absorption of FA from various fat sources.

Key Words: Fat, Fatty Acids, Energy

68 Field applications of manure evaluation. M.F. Hutjens*, *University of Illinois, Urbana*.

Manure evaluation on dairy farms can be one method to evaluate feeding programs and dietary changes. Three field approaches will be discussed including manure scoring, washing, and testing. Manure scoring developed by Michigan State workers uses a one (watery) to five (dry and stiff) score that can be related to nutrient balance, stage of lactation, and milk yield. Manure washing consisted of screening eight ounces of fresh manure through a 2200 microns screen. Feed particles on the screen reflect forage quality (forage particles over 12 mm are undesirable), presence of corn grain (from corn silage and grain reflect nutrient loss), and passing of oil seeds (presence of soybean seed or whole cottonseed reflect undesirable processing). Manure testing involved analyzing manure for starch, pH, and fiber content to evaluate nutrient and ration digestion. Fresh manure from thirteen Holstein cows (less than 60 days postpartum) was collected for evaluation. Cows ranged in dry matter intake from 20.1 to 27.6 kg with milk yield varying from 34.1 to 54.1 kg of milk per day. Fecal starch, dry matter, and pH values were analyzed by a commercial lab. Fecal starch varied from 2.3 to 22.4 percent, fecal pH values ranged from 5.4 to 6.5, and fecal dry matter varied from 9.2 to 11.6 percent. No significant relationships were found between manure values and milk yield, dry matter intake, or days in milk.

Key Words: Manure, Dairy, Evaluation

Graduate Student Competitive Research Papers - Ph.D. Division

69 Influence of prepubertal dietary protein level and age at first calving on early-weaned replacement beef heifer performance. W. J. Sexten*, D. B. Faulkner, and F. A. Ireland, *University of Illinois at Urbana-Champaign*.

Simmental x Angus heifer calves (n=310) were utilized in a 2 x 2 factorial arrangement to evaluate prepubertal dietary protein level and age at first calving on performance, reproductive and maternal traits. Heifer calves were weaned early at 67 ± 19.9 days of age and fed either a 19% or 23% CP diet and bred to calve at 18 (18M) or 24 (24M) months of age. Diets were isocaloric, calculated to provide 2.32 Mcal NE_m/kg DM and 1.42 Mcal NE_g/kg DM. Eighteen-month heifers were offered feed *ad libitum* from weaning to breeding while 24M heifers were limit fed at 1.8% of BW. Data were analyzed using the MIXED and GENMOD procedures of SAS. Diet did not significantly ($P > 0.05$) influence prebreeding ADG, breeding weight, hip height, pelvic area, or fat thickness. Prebreeding ADG was greater ($P < 0.05$) for 18M (1.1 kg) than 24M (0.67 kg). Eighteen-month heifers were lighter, (305.1 kg) shorter (116 cm) and fatter (0.64 cm) at breeding than 24M heifers (319.0 kg, 122.6 cm, and 0.39 cm) ($P < 0.05$). The 18M heifers remained lighter and shorter ($P < 0.05$) through weaning of their first calf yet BCS was not influenced ($P = 0.16$). Prepubertal dietary protein did not influence ($P > 0.05$) pregnancy, calving or weaning percentages. Pregnancy, calving and weaning percentages tended ($P < 0.10$) lower for 18M heifers (51%, 45.8% and 39.7%) compared to 24M (66.7%, 62.5% and 53.5%). Birth weight and calving ease were not influenced ($P > 0.05$) by prepubertal dietary protein level or age at first calving. Milk production, calf weaning weight and calf birth to weaning ADG were not influenced ($P > 0.05$) by prepubertal dietary protein treatments. Milk production, calf weaning weight and calf birth to weaning ADG were reduced in 18M (3.8 kg, 69.2 kg and 0.53 kg/d) compared to 24M (5.1 kg, 82.0 kg and 0.68 kg/d) ($P < 0.05$). Prepubertal dietary protein level did not influence performance, reproductive or maternal traits. Eighteen-month calving heifers entered the herd earlier however reproduction and maternal performance was reduced.

Key Words: Heifer Development, Dietary Protein, Age at First Calving

70 Effect of corn distiller's dried grains with solubles (DDGS) and/or antimicrobial regimen on the ability of growing pigs to resist a Lawsonia intracellularis challenge. M. H. Whitney*, G. C. Shurson, R. M. Guedes, C. J. Gebhart, and N. L. Winkleman, *University of Minnesota, St. Paul, MN,* [2]*Swine Services Unlimited, Inc., Morris, MN*.

Two experiments were conducted to determine if including DDGS in the diet reduces the incidence and/or severity of infection in growing pigs after a L. intracellularis challenge. In Experiment 1, eighty 17-d old weaned pigs were blocked by sex and weight and randomly allotted to one of four treatment groups: negative control (NC) - unchallenged, corn-soy diet; positive control (PC) - challenged, corn-soy diet; 10% DDGS diet (10D) - challenged; and 20% DDGS diet (20D) - challenged. Challenged pigs were orally inoculated with 1.5 x 10^9 L. intracellularis after a 4-wk pre-challenge period. On d 21 post-challenge, pigs were euthanized, lesions of intestinal mucosa was evaluated, and ileal tissue samples were analyzed by immunohistochemistry to determine presence and proliferation of L. intracellularis. Feeding DDGS did not beneficially affect lesion length, prevalence, proliferation of L. intracellularis, or severity of lesions ($P > .10$). In Experiment 2, 100 pigs were managed similarly to pigs in Experiment 1, except that the dosage of L. intracellularis was reduced to 8.0 x 10^8. Treatments consisted of NC and 4 challenged groups: PC, 10D, PC + AR (antimicrobial regimen), and 10D + AR. For AR treatments, diets contained 30 g/ton BMD® continuously, with Aureomycin® pulsed at 500 g/ton from d 3 pre-challenge to d 11 post-challenge. Feeding DDGS reduced ileum and colon lesion length and prevalence ($P < .05$), and reduced severity of lesions in the

ileum (P < .05) and colon (P < .10) compared to other challenged pigs. Pigs fed AR had a lower prevalence and severity of lesions in the jejunum (P < .05), and tended to have reduced total tract lesion length (P = .11). No differences in length, severity, or prevalence of lesions were observed in 10D + AR pigs (P > .15), but fecal shedding of L. intracellularis was reduced on d 14 post-challenge (P < .05). No dietary effects on fecal shedding were observed by d 20 post-challenge (P < .10). Proportion of cells infected with L. intracellularis was reduced when DDGS (P = .05) or antimicrobials (P = .10) were fed. Dietary inclusion of DDGS may provide some benefit to growing pigs subjected to a moderate ileitis challenge, similar to a currently approved antimicrobial regimen, but not under conditions of a severe L. intracellularis challenge.

Key Words: Pig, Ileitis, Distiller's Dried Grains with Solubles

71 Selection for placental efficiency in swine: Genetic parameters and trends.

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Direct and maternal genetic parameters and trends were estimated using data from two lines divergently selected for three generations on an index that included litter size (**LS**), birth weight (**BW**), and placental weight (**PW**). The index was designed to modify LS through changes in placental efficiency (**PE**), defined as the ratio of BW: PW. Animal model and MTDFREML procedures were used to estimate direct and maternal genetic effects and their correlations and to compute estimated breeding values (**EBV**) for BW (n=1788), PW (n=1442), PE (n=1442), and LS (n=125). The model included the fixed effects of generation and line, with the addition of parity number for LS and of sex for the other traits. Contemporary group was fitted as an uncorrelated random effect for all traits. Quadratic regression on LS was used as a covariate for BW, PW, and PE. Direct heritability estimates from single-trait models were .02, .21, .09, and .08 for BW, PW, PE, and LS, respectively. Maternal heritability estimates were .39, .38, .29, and .03 for BW, PW, PE, and LS, respectively. Genetic correlations between direct and maternal effects were -.51 and -.20 for PW and PE, respectively, and were outside the parameter space for BW and LS. Direct genetic correlations from two-trait models were .77 for BW and PW, -.27 for BW and PE, -.69 for PW and PE, -.19 for LS and BW, -.78 for LS and PW, and .37 for LS and PE. The GLM procedure of SAS was used to compare EBV lsmeans; the model included generation, line, and replicate within line. Divergence trend in direct EBV was 2.13 1.11 g, 17.12 2.34 g, .12 .02, and .00 piglets per generation for BW, PW, PE, and LS, respectively. At generation three, direct EBV tended to be higher in the upward (**H**) than the downward (**L**) selected line for BW (.81 2.05 g vs. -6.19 2.21 g, respectively; P=.10), tended to be lower in H than L for PW (-1.48 11.02 g vs. 34.62 11.85 g, respectively; P=.07), and were not different for PE (P=.14). These results indicate that BW, PW, and PE are susceptible to change by genetic selection, but the magnitude of the divergence observed did not result in detectable differences in LS.

Key Words: Genetic Parameters, Placental Efficiency, Pigs

72 Improvement of pregnancy rate to fixed-time artificial insemination with progesterone treatment in anestrous post-partum cows.

C.L. Gasser*, E.J. Behlke, C.R. Burke, D.E. Grum, M.L. Mussard, and M.L. Day, *The Ohio State University*.

Potential for pregnancy in anestrous cows requires elevation of progesterone concentration (P4) before ovulation. Utilization of an intravaginal progesterone-releasing insert (IPI) ensures that elevated P4 occurs in all anestrous cows. The objective of this study was to determine if treating anestrous cows with an IPI prior to synchronized ovulation would increase the pregnancy rate to fixed-time AI (TAI). Blood samples collected from post-partum beef cows (n = 419) on d -18 and d -9 (TAI = d 0) were analyzed for progesterone concentration; ovarian ultrasonography was performed on d -9; and cows were categorized accordingly as either estrous-cycling (CYC, n = 235) or anestrous (ANES, n = 184). All cows in the study received GnRH (100 μg) on d -9. ANES cows either were not treated (CONT, n = 111) or received an IPI (CIDR, n = 73) on d -9. All cows in the study were given prostaglandin $F_2\alpha$ on d -2, at which time the IPI was removed from ANES, CIDR-treated cows. In cows that exhibited estrus at least 24 h before d 0, AI was performed within 12 h (Early AI). In all other cows, TAI was performed on d 0, and those that were not detected in estrus 12 h previously received GnRH at TAI. None of the ANES, CIDR-treated cows exhibited estrus more than 12 h before TAI, whereas Early AI was performed in 11 and 3% of ANES, CONT-treated and CYC cows, respectively (P < 0.05). Conception rate at TAI was greater (P < 0.05) in ANES, CIDR-treated (55%) than ANES, CONT-treated cows (39%) and not different than the CYC group (54%). Consequently, pregnancy rate to TAI also was greater in ANES, CIDR-treated (55%) than ANES, CONT-treated cows (35%) and not different than the CYC group (53%). In conclusion, pregnancy rate to TAI was increased with progesterone treatment in anestrous cows through preventing premature estrus and increasing conception rate.

Key Words: Anestrous, CIDR, Synchronization

73 Increasing weaning age improves pig growth performance and profitability in a three-site production system.

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

Two trials were conducted to determine the effects of weaning age on growing pig biologic and economic performance in a three-site production system. Trial 2 also evaluated the effects of modifying nursery feed budgets according to weaning age. In trial 1 (2,272 pigs), treatments included weaning litters at 12, 15, 18, or 21 d of age. In trial 2 (3,456 pigs), litters were weaned at 15, 16, 18, 19, 20, or 21 d of age and categorized into three treatments (15.5, 18.5, or 21.5 d of age). In trial 2, pigs in each age group were fed a nursery feed budget classified as more or less complex. Since feed budget did not affect (P>0.27) performance, only weaning age effects are presented. Each trial was conducted as a randomized complete block design with four blocks of linked nursery and finishing sites (6 and 10 reps/block in trials 1 and 2, respectively). All wean age treatments were weaned from a 7,300-head sow farm on the same day into the same nursery. Each block remained intact as pigs moved from nursery to finishing site. Costs and revenue were measured for each pen. Increasing weaning age (12, 15, 18, or 21; and 15.5, 18.5, or 21.5 in trials 1 and 2, respectively) improved (linear, P< 0.03) wean-to-finish ADG (580, 616, 637, 687 8 g/d; 676, 697, 722 6 g/d), mortality rate (9.4, 7.9, 6.8, 3.6 0.95 %; 3.9, 3.4, 2.5 0.5 %), weight sold per pig weaned (94.1, 100.5, 104.4, 113.1 1.3 kg, 107.6, 111.6, 116.2 1.1 kg), income over costs ($2.00, 5.11, 7.12, 11.19 0.52/pig; $7.99, 10.04, 12.46 0.46/pig), and cost per hundred kg sold ($86.19, 83.24, 81.49, 78.36 0.46; $80.80, 79.25, 77.50 0.32). The improvements in growth and mortality largely occurred in the initial 42 d after weaning, with smaller growth improvements in finishing. These studies indicate that increasing weaning age up to 21.5 d predictably improves grow-finish throughput (1.80 0.12 kg sold/pig/d of age) and profitability ($0.89 0.05/pig/d of age) within this three-site production system.

Key Words: Weaning Age, Pigs, Economics

74 Predicting bacterial crude protein production from urinary allantoin in spot samples.

R.A. McDonald*, T.J. Klopfenstein, G.E. Erickson, and T.W. Loy, *University of Nebraska-Lincoln, Lincoln, NE*.

A metabolism trial was conducted to determine if allantoin in spot urine samples could be a predictor of bacterial CP (BCP) production in finishing heifers. Three diets, formulated to produce differences in BCP production, were fed to six ruminally fistulated heifers (BW=596±47 kg) in a 3 x 6 latin rectangle design. The high-moisture corn (HMC) diet was 88.3% HMC, 6.7% cottonseed hulls, and 5.0% dry supplement (DM basis). In the BRAN diet, 20% corn bran replaced HMC. Urea was included at 0.9% of DM in these two diets. In the third diet, urea was removed from the BRAN diet, and soybean meal (SBM) replaced HMC at 7.8% of DM. Periods consisted of 9 d for adaptation and 5 d for collection. Spot urine and fecal grab samples were collected daily (0800, 1100, 1400, and 1700 h), and rumen pH and intake data were monitored continuously. BCP (g/d) production from allantoin excretion (BCP-A) was lower for HMC (750) versus BRAN (962; P=0.02) or SBM (909; P=0.07). Bacterial efficiency (P=0.15) and average pH (P=0.13) tended to be lower for HMC (8.8 and 5.44) than BRAN (10.3 and 5.78) and SBM (10.8 and 5.88). Dry matter digestibility (P=0.08) was higher for HMC (85.0) than BRAN (81.6) and SBM (80.0) with no difference in digestible DMI (P=0.45). Regression analyses suggest that efficiency increased with increasing pH and decreased as time below pH of 5.6 increased. Increasing digestible DMI increased BCP-A with an efficiency of 13.1%. BCP-A followed NRC estimates (BCP-NRC) of BCP.

These relationships suggest allantoin excretion is an effective marker of BCP production.

Dependent Variable	Independent Variable	Intercept	Slope	R^2
Efficiency	Average pH	-4.87	2.59	34.8
Efficiency	Time below 5.6	11.9	-0.003	51.7
BCP-A	Digestible DMI	-259	13.1	56.7
BCP-NRC	BCP-A	198	0.853	55.0

Key Words: Allantoin, Bacterial Crude Protein, Cattle

75 Lactose in dairy cow diets increases ruminal butyrate proportions resulting in an increase in plasma betahydroxybutyrate in late lactation. J. M. DeFrain*, A. R. Hippen, K. F. Kalscheur, and D. J. Schingoethe, *South Dakota State University*.

Ruminal fermentation of lactose increases molar proportions of butyrate. Butyrate is metabolized by the ruminal epithelium to betahydroxybutyrate (BHBA); however, little data exists on the effect of lactose on plasma BHBA. Eight Holstein and four Brown Swiss multiparous cows (210 ± 33 DIM) were used to determine the effect of feeding lactose on plasma BHBA. Cows were blocked by breed and randomly assigned to one of three, 4×4 Latin squares. Treatments were control (CON, 7.1% of diet DM corn starch), liquid whey (WHEY, 9.4%) containing 70% lactose on a DM basis, low lactose (LOLAC, 7.1% lactose), or high lactose (HILAC, 14.3% lactose). All diets contained 16% alfalfa hay, 3.7% brome grass hay, 32% corn silage, 7% whole cottonseed, 11% soybean meal, and 8% dried distillers grain. Average diet CP% and energy density (Mcal/kg NE_L) were 16.8 and 1.47, respectively. Lactose linearly increased ($P < 0.05$) DMI; however milk production was not affected by diet. With the exception of MUN, milk composition was not affected by diet. Increasing lactose linearly decreased MUN ($P < 0.05$). Molar proportions of propionate responded quadratically as higher proportions of propionate were observed in cows fed CON and HILAC. Increasing dietary lactose caused linear increases ($P < 0.05$) in proportions of ruminal butyrate and linear decreases ($P < 0.05$) in acetate and branched chain fatty acids (BCFA). Increasing lactose tended to linearly decrease glucose ($P < 0.10$) and increase BHBA ($P < 0.01$) in plasma. These data demonstrate lactose fermentation increases proportions of ruminal butyrate causing a subsequent increase in plasma BHBA in late lactating dairy cows.

Item	CON	WHEY	LOLAC	HILAC	SEM
DMI[1], kg/d	21.7	22.6	22.3	23.3	1.16
MUN[1], mg/dl	15.12	13.23	14.84	13.79	0.445
Rumen fluid					
Acetate[1], %	60.6	59.9	59.5	57.3	0.64
Propionate[2], %	22.3	20.8	20.9	21.6	0.54
Butyrate[1], %	13.9	16.1	16.3	18.0	0.38
BCFA[1], %	1.83	1.62	1.73	1.27	0.162
Plasma					
Glucose[1], mg/dl	68.0	67.7	66.5	65.5	1.52
BHBA[1], mg/dl	2.01	2.70	2.55	3.61	0.296

[1]Linear and [2]Quadratic lactose effects.

Key Words: Rumen, Butyrate, Ketones

Graduate Student Competitive Research Papers - M.S. Division

76 The effects of dietary okara on performance of nursery pigs. J.R. Hermann* and M.S. Honeyman, *Iowa State University*.

Okara is the residue left from ground soybeans after the production of soymilk and tofu. Interest in okara exists because there is a need for a reliable source of high quality protein for organic pig production. Organic soymilk and tofu production is well established. The objective was to determine the effectiveness of dietary okara on performance of nursery pigs. Four replicate trials involving a total of 48 pigs (13.17 kg 0.32) were conducted at the Iowa State University Swine Nutrition Farm. The pigs and feeders were initially weighed and at 7 d intervals until the completion of each 18 d trial. Average daily gain (ADG), average daily feed intake (ADFI), and gain:feed (G:F) ratio were recorded for each pen. During each trial, three dietary treatments were fed: 1) okara 25% (25% of total diet), 2) okara 50% (50% of total diet), and control diet (composed of corn, soybean meal, oats, and essential vitamins and minerals). All diets contained 10% oats. Okara (ground pellets) was added to the diets at 25 and 50% levels by weight. Diets were isolysinic based on calculated analysis. Pigs were initially allotted by weight to one of three treatments. There were four pigs per pen for a treatment in each replication. Among pigs receiving dietary okara there were no differences in ADG, ADFI, and G:F ratio compared to pigs receiving the control diet. Pigs fed okara 25% had a higher ADG when compared to 50% okara ($P< 0.06$). Total G:F ratio was increased when diets supplemented with 25% were fed compared with 50% ($P < 0.04$). Dietary okara is a potential alternative to soybean meal in nursery pig diets. More research is needed to determine the levels at which okara can be substituted in the diet. The 50% okara rate was comparable to a conventional nursery pig diet. The 25% okara rate was equal and may be superior to a conventional nursery pig diet in growth and feed efficiency.

Key Words: Okara, Nursery Pigs, Soybean Meal

77 The effect of intravenous infusion of glucose on ethanol stability of milk in Holstein dairy cows. S. Sobhani*, R. Valizadeh, and A. Neserian, *Agricultural College of Ferdowsi University, Mashhad, Iran*.

The alcohol test is used as the initial classification of milk in dairy farms. It's used as a measure of the natural pH of milk, which is a critical factor for stabilizing casein micelles in milk serum phase during heating. In practical conditions the test may also be positive immediately after milking and this type of milk is rejected by dairy processing industry. An experiment was conducted to evaluate the effect of negative energy balance and low levels of blood glucose on incidence of alcohol-positive milk in Holstein high milking cows. Four multiparous dairy cows in mid lactation stage and average milk yield of 35 kg/d (s.d. 2.8) and mean ethanol stability of 58% (s.d. 3) were used. Four central venous catheters were inserted in jugular vein and the cows housed in individual tie stalls. The cows adapted to the new conditions during a five-days period. The cows infused in two consecutive two-days periods with 100 and 200 g/d glucose solutions through jugular vein respectively. Solutions were infused at the rate of 2 ml/min and the experiment was ended after a two-days post-treatment period. At the end of each period blood and milk samples were collected. Milk samples were analyzed for fat, protein, lactose, total solid, casein and pH. Blood plasma samples were analyzed for determination of glucose. Ethanol stability and dry matter intake were measured daily for individual cows. The experimental design used four cows that were randomized in an incomplete Latin square design. No significant difference was observed between infusion periods for fat, protein, lactose and casein content of the milk samples, although total solid content of milk samples and blood glucose level differed significantly ($P \leq 0.05$) with increasing the level of infused glucose. The ethanol stability of milk and dry matter intake decreased by increasing infused glucose. The lack of improvement in ethanol stability, which was the main object of this study, can be attributed to intake reduction as a result of increasing blood glucose to an abnormal range and stress of treatment application in a short period and unfavorable conditions. Therefore, it seems that in a long period and favorable conditions glucose infusion can positively affect ethanol stability of milk in high milking dairy cows.

Key Words: Ethanol Stability, Glucose Infusion, Dairy Cows

78 Anti-diabetic potentials of *Momordica charanta* and *Andrographis paniculata* and their effects on estrous cyclicity of Alloxan-induced diabetic rats. B. Reyes[1], N. Bautista*[1], N. Tanquilut[1], R. Anunciado[2], A. Leung[1], G. Sanchez[1], R. Magtoto[3], S. Sajapitak[4], H. Tsukamura[4], and K.-I. Maeda[4], [1]*Pampanga Agricultural College, Magalang, Philippines,* [2]*University of the Philippines, Los Banos, laguna, Philippines,* [3]*Iowa State University, Ames, Iowa,* [4]*Nagoya University, Nagoya, Japan.*

Momordica charanta and *Andrographis paniculata* are commonly used herbs by the diabetic folks in Pampanga, Philippines. While the anti-diabetic potential of *M. charanta* is well established, it is not known whether *A. paniculata* possesses anti-diabetic property. Moreover, the effects of these herbs on estrous cyclicity of diabetic rats are not known. Thus, in this experiment, we determined the anti-diabetic potentials of *M. charanta* and *A. paniculata* and their abilities to restore estrous cyle in Alloxan-induced diabetic rats. Extract and decoction of *M. charanta* and *A. paniculata*, respectively, were administered orally to Alloxan-induced diabetic rats from the day they showed diabetes through the blood and urinary glucose levels until the last day of the experiment. There were two groups of rats that served as positive (untreated Alloxan-induced diabetes) and negative controls. Rats treated with *M. charanta* and *A. paniculata* had higher body weight (BW) and lower feed and water intake compared with positive control starting from day 16 (D16) to D26 ($P<0.05$), though lower BW and higher feed and water intake compared with negative controls ($P<0.05$). Urinary glucose could not be detected in the *M. charanta*- and *A. paniculata*-treated rats from D11 to D26. The blood glucose levels in *M. charanta*-and *A. paniculata*-treated rats were significantly reduced from D11 to D26 compared with positive controls ($P<0.05$) and comparable with negative controls ($P<0.05$). *M. charanta* and *A. paniculata* demonstrated potentials in the restoration of estrous cyclicity at about 8.4 days from the day it was disrupted. The reduction of blood glucose levels and restoration of estrous cycle in Alloxan-induced diabetic rats treated with *M. charanta*-and *A. paniculata* indicate that the herbs possess anti-diabetic potentials that could restore impaired estrous cycle.

Key Words: Diabetes, Estrous Cycle, Herbs

79 Effect of flax supplementation and a combined trenbolone acetate and estradiol implant on circulating IGF-1 and muscle IGF-1 mRNA levels in finishing cattle. J. D. Dunn*, J. P. Kayser, A. T. Waylan, E. K. Sissom, J. S. Drouillard, and B. J. Johnson, *Kansas State University, Manhattan.*

Combined trenbolone acetate (TBA) and estradiol (E_2) growth promotants have been reported to increase circulating IGF-1 and muscle IGF-1 mRNA levels in finishing cattle. The purpose of this experiment was to evaluate the effects of a 5% ground flaxseed (FLAX) supplement and a combined TBA/E_2 growth promotant, Revalor-S, (IMP) on both circulating IGF-1 and local muscle IGF-1 mRNA concentrations. Sixteen crossbred steers (initial BW = 397 kg) were randomly assigned to one of four treatments: 1) FLAX/IMP, 2) No FLAX/IMP, 3) FLAX/No IMP, 4) No FLAX/No IMP. Data were analyzed as a 2×2 factorial in a split-plot design (4 steers/treatment). Steers were allowed ad libitum access to a 93% concentrate diet for the entire study. Serum was harvested from blood collected via jugular venipuncture on d 0 (before implantation or FLAX addition), 14 and 28, and stored for subsequent use in analysis of circulating IGF-1 levels. Muscle biopsy samples (3.5 g) were obtained from the longissimus muscle on d 0, 14, and 28. Total RNA was isolated from the muscle samples and real-time quantitative-PCR was used to evaluate relative differences in gene expression. FLAX supplementation had no effect ($P > 0.10$) on circulating IGF-1 levels. No FLAX cattle had increased levels of muscle IGF-1 mRNA as compared to FLAX cattle on d 28 (4.4-fold, $P < 0.01$). Following implantation, sera from IMP steers had 52 and 84% greater ($P < 0.05$) IGF-1 levels as compared to sera from No IMP steers on d 14 and 28, respectively. On d 28, local muscle IGF-1 mRNA levels were increased 2.4-fold ($P < 0.01$) in biopsy samples obtained from IMP as compared to No IMP steers. These data support that the administration of a combined TBA/E_2 growth promotant increases circulating IGF-1 and local muscle IGF-1 mRNA concentrations in finishing cattle. However, this increase in muscle IGF-1 mRNA appears to be attenuated by the addition of a FLAX supplement.

Key Words: Beef Cattle, IGF-1, Trenbolone Acetate

80 Influence of weaning age, creep feeding and type of creep on steer performance and carcass traits. D. W. Shike*[1], D. B. Faulkner[1], D. F. Parrett[1], F. A. Ireland[1], and M. J. Cecava[2], [1]*University of Illinois at Urbana-Champaign,* [2]*Consolidated Nutrition, Fort Wayne, IN.*

Angus x Simmental steers (n=168) were assigned to four treatments: Early Wean/High Concentrate (EW), Normal Wean/Creep (C), Normal Wean/Fiber Creep (FC) and Normal Wean/No Creep (NC) to determine the effects of weaning age, creep feeding and type of creep on calf performance and carcass traits. Steers were weaned at 63 ± 16.3 or 189 ± 16.3 d of age. EW steers were fed to gain the same as the two creep-fed (CR-F) treatments during the growing period. Data were analyzed using the GLM and GENMOD procedures of SAS. There was no difference ($P > 0.05$) in gain between EW steers and CR-F steers during the growing period. However, C steers had higher ADG (1.37 kg/d) and supplemental gain/feed (0.16) than FC steers (1.29 kg and 0.12) ($P < 0.05$), but DMI was not different. During the adaptation period, EW steers had higher DMI (7.87 kg/d) and ADG (1.93 kg/d) than CR-F steers (4.89 kg/d and 1.14 kg/d) ($P < 0.05$), with no differences in feed efficiency. The NC steers had lower DMI (3.9 kg/d), ADG (0.40 kg/d) and feed efficiencies (0.10) than other treatments (5.88 kg/d, 1.40 kg/d and 0.23) ($P < 0.05$). During the finishing period, EW steers had lower DMI (7.99 kg/d) and ADG (1.36 kg/d) than CR-F steers (8.45 kg/d and 1.5 kg/d) ($P < 0.05$). Intake, ADG and feed efficiencies were not different between NC steers and other treatments or between C and FC. Overall, NC steers had lower ADG (1.28 kg/d) and were older at harvest (407 d) than other treatments (1.4 kg/d and 395 d) ($P < 0.05$). There were no differences in gain or days to slaughter between EW and CR-F steers or between C and FC. The EW steers had a higher marbling score (663), a higher percent $\geq$ Choice$^{\circ}$ (72.5%) and a higher percent $\geq$ Prime^{-} (12.5%) than CR-F steers (598, 38.8% and 2.5%) ($P < 0.05$). There was no difference in yield grade. Feeding EW steers high concentrate diets improved carcass quality compared to creep feeding. Type of creep did not influence carcass quality or overall performance.

Key Words: Early Weaning, Creep Feeding, Steers

81 Effects of long-term treatment with GnRH agonist on testicular development and the attainment of puberty in bull calves. E.J. Behlke*, C.R. Burke, C.L. Gasser, M.L. Mussard, and K.E. Fike, *The Ohio State University.*

Onset of puberty in bulls is regulated by gonadotropins and testosterone (T). GnRH agonist treatment in bulls decreases LH pulse frequency but increases basal LH and testosterone secretion. Our hypothesis was that long-term treatment of prepubertal bulls with a GnRH agonist (deslorelin) will induce earlier onset of puberty and increase testicular size and function, as compared with bulls receiving GnRH or no treatment. From 164 to 360 average days of age, Angus and Angus x Simmental bull calves were treated with deslorelin (1 μg/kg BW/d : DES, n = 7), gonadorelin (5 μg/kg BW/d : GnRH, n = 7) or remained untreated (CON, n = 7). Treatments were administered via mini-osmotic pumps, implanted s.c., and replaced every 28 d. Scrotal circumference (SC) was measured every 2 weeks. Blood samples were collected every 20 min for 24 h at 185 and 358 d of age to determine concentrations of LH and T. When bulls attained a SC of 26 cm, they were electro-ejaculated once every 2 wks and considered pubertal when the first of three ejaculates contained > 50 x 10(6 total sperm with > 10% progressive linear motility. At 421 d of age, testicles were removed and testicular size, mass and daily sperm production (DSP) were measured. The SC of bulls treated with DES was different ($P \leq 0.10$) as compared with GnRH treated bulls from 276 d of age until the end of treatments. The SC of CON bulls did not differ from that of DES or GnRH treated bulls at any time throughout the experiment. Treatment with DES decreased ($P < 0.05$) LH pulse frequency and amplitude but increased ($P < 0.05$) basal LH secretion during treatment as compared with CON bulls. Also, DES treatment increased ($P < 0.05$) basal T secretion throughout treatment as compared with GnRH treated and CON bulls. Age at puberty or testis size, mass and DSP at castration did not differ among groups. We conclude that long-term treatment with deslorelin increases basal and mean LH and T, but does not alter testicular size nor hasten the onset of puberty in bulls.

Key Words: Bull, Puberty, Testosterone

82 Fetal growth and development in the pig: nutritional implications. R. L. McPherson*[1], F. Ji[1], G Wu[2], and S. W. Kim[1], [1] *Texas Tech University,* [2] *Texas A&M University.*

A total of 304 fetuses from 25 primiparous sows were used in this study to determine fetal growth and development during gestation. All the sows were fed equal amounts (2.0 kg/d) of the same diet and housed in crates. Sows were slaughtered in groups representing days of gestation: 45 (6-sows), 60 (4- sows), 75 (3-sows), 90 (3-sows), 100 (5-sows), and 110 (4-sows). An additional 6 primiparous sows were slaughtered on day 0 of gestation to provide baseline information. The reproductive tracts were obtained from all the sows after slaughter and dissected to obtain the fetuses. Fetuses were dissected into individual tissues, including carcass, gastrointestinal tract (GIT), liver, lung, heart, kidney, spleen (75+days), and placenta. All the individual tissues were weighed. Regression equations were obtained to explain the weight changes of individual tissues during gestation. Based on the regressions, weight gains from the fetus, carcass, gastrointestinal tract (GIT), liver, lung, heart, kidney, spleen and placenta during gestation (d 0 to d 114) were 1,674.8, 1,437.6, 104.3, 44.2, 56.5, 14.1, 17.8, 2.5 and 34.1 g/fetus. There was a quadratic relationship between liver ($P < 0.0001$) or placental weight ($P < 0.0001$) and the fetus weight. There was a cubic relationship between heart weight ($P < 0.0001$) and fetal weight. There was a linear relationship between the gastrointestinal tract ($P < 0.0001$) or kidney ($P < 0.0001$) and fetal weight. During gestation, the proportion of the GIT increased linearly ($P < 0.0001$) with fetal weight, whereas the liver decreased linearly ($P < 0.0001$) with fetal weight. The growth of liver and the GIT occurs early in gestation (before d 70) and during late gestation (after d 70), respectively. These results may have important implications for establishing a feeding strategy for gestating sows to improve fetal growth.

Key Words: Pigs, Fetus, Growth

83 Sorting strategies for yearlings. J.C. MacDonald*, T.J. Klopfenstein, G.E. Erickson, C.N. Macken, J.D. Folmer, and M.L. Blackford[1], [1] *University of Nebraska - Lincoln.*

One hundred sixty medium-framed English-cross steers (244 kg; SD = 23 kg) were used in each yr of a two yr study to determine the effects of three sorting strategies on performance, carcass characteristics, and profitability in an extensive beef production system. The hypothesis was sorting yearling cattle by weight or fat depth would increase carcass weight, reduce discounts for overweight and over fat carcasses, reduce variability in carcass weight and carcass fat thickness, and improve profitability. Treatments were 1) sorting by weight prior to summer grazing with heaviest half removed midway through grazing season, i.e. pasture sort (PSTR; n = 40), 2) Sorting by weight entering feedlot (FDLT; n = 40), 3) Sorting by weight and fat thickness at end of feeding period (PEN; n = 60), and 4) control that was not sorted (CON; n = 20). All steers received two implants (Revlor-G® for grazing and Revlor-S® entering feedlot). Average days on feed were 99, 90, 87, and 83 for PSTR, FDLT, PEN, and CON, respectively. No differences were observed for winter or summer performance (0.65 and 0.78 kg/d, respectively; $P \geq 0.10$). The CON and sort groups of each treatment were marketed when fat depth of the group reached 1.14 cm. Individual steers in PEN treatment were marketed upon reaching 1.14 cm fat depth or 680 kg shrunk body weight. PSTR cattle were lighter entering feedlot ($P \leq 0.01$), consumed less feed ($P \leq 0.01$), and gained less ($P \leq 0.05$) than other treatments. There were no differences in feed efficiency ($P = 0.81$) suggesting gain differences were related to DMI. PSTR cattle also had less variation in weight upon entering the feedlot ($P \leq 0.01$), which resulted in less variation in carcass weight ($P \leq 0.05$). The PSTR treatment also resulted in increased marbling scores ($P \leq 0.01$), and was only treatment that resulted in no overweight carcasses. No differences were found in carcass weight or profitability ($P \geq 0.10$). No sorting strategy successfully accomplished all hypothesized improvements.

Key Words: Sorting, Beef Production Systems, Carcass Variability

84 Effects of adding distiller's dried grain with solubles (DDGS) to gestation and lactation diets on reproductive performance and nutrient balance in sows. J.A. Wilson*[1], M.H Whitney[1], G.C. Shurson[1], and S.K. Baidoo[2], [1] *University of Minnesota, St. Paul, MN,* [2] *University of Minnesota, Waseca, MN.*

A two-parity study utilizing 93 sows was conducted to determine the effects of diets containing 50% DDGS in gestation and 20% DDGS in lactation on sow reproductive performance. Nutrient balance was determined from d 100 to 105 of pregnancy using 14 sows. Sows were allotted based on parity and initial BW to a corn-soybean meal gestation diet (GC) or GC + 50% DDGS (GDG), and a corn-soybean lactation diet (LC) or LC + 20% DDGS (LDG) in a 2 × 2 arrangement of treatments. Sows were fed 1% BW plus 100 g, 300 g, and 500 g per d on d 30, 60, and 90 of gestation, respectively, and were provided *ad libitum* access to feed during lactation. Sows remained on their respective diets through two reproductive cycles (RC1 and RC2). No differences in sow gestation weight gain, pigs born alive per litter, and litter birth weight were observed between sows fed GC and GDG. Dietary treatment combination had no effect on litter size or litter weight at weaning for RC1, but sows fed GC/LC weaned fewer pigs per litter during RC2 ($P < .05$). Preweaning piglet mortality was higher ($P < .05$) for sows fed GDG/LDG compared to other treatments during RC1, but dietary treatment combinations had no effect during RC2. Sows fed GC/LDG in RC1 had lower lactation feed intake ($P < .01$), which primarily occurred within the first 7 d of lactation, but this effect was not observed during RC2. Wean-to-estrus interval was higher ($P < .001$) for sows fed the GC/LC diet combination compared to sows fed the GDG/LDG and GDG/LC diet combinations (5.8 vs. 4.8 and 4.4d) during RC1, but was not observed during RC2. Sows fed GDG diet had greater N, S ($P < .05$), and P retention ($P < .1$) than sows fed the GC diet. These results suggest that feeding a gestation diet containing 50% DDGS will support satisfactory reproductive performance, but feeding a 20% DDGS lactation diet may reduce feed intake if sows were fed a corn-soybean meal diet during gestation.

Key Words: Sow, Distiller's Dried Grains with Solubles, Reproductive Performance

85 Nitrogen balance and blood urea nitrogen as response criteria to estimate protein requirement of the exercising horse. C.L. Wickens*, J. Moore, J. Shelle, C. Skelly, H.M. Clayton, and N.L. Trottier, *Michigan State University, East Lansing, Michigan/USA.*

Five mature Arabian geldings (475.55 ± 38.50 kg body weight) were used to first, determine if nitrogen (N) retention (R) and blood urea nitrogen (BUN) can be used as response criteria to estimate dietary crude protein (CP) requirement for moderate exercise and second, to determine if N balance and BUN, when used simultaneously, provide similar estimates of protein requirement. Horses were randomly assigned to 1 of 5 dietary treatments in a 5 x 5 Latin Square design. All horses consumed mixed grass hay containing 10% CP at 1% of their body weight. Total diet (hay plus concentrate) was formulated to provide 677, 790, 903, 1016 and 1129 g CP daily corresponding to a very low (VL), low (L), control (C), high (H), and very high (VH) protein diet respectively. Horses were trotted bi-directionally on a mechanical walker at approximately 3.6 meters per second for 60 minutes per day, 6 days per week. Each N balance period was 14 days in length and consisted of a 10-day diet adaptation followed by a 4-day total urine and fecal collection. Pre and post-exercise blood samples were drawn from each horse on day 3 and 4 of the collection period and analyzed for urea-N concentration. There was no difference ($P>0.05$) in NR (g/d) between VL (24.80 ± 4.95), L (29.30 ± 5.21), and C (33.02 ± 4.95). Nitrogen retention (g/d) increased ($P<0.05$) in H (46.18 ± 4.95) versus VL, L, or C. Nitrogen retention (g/d) in VH (48.29 ± 4.95) was not different ($P>0.05$) compared to H, and was higher ($P<0.05$) compared to VL, L, or C. Pre-exercise BUN increased ($P<0.05$) with increasing CP intake. There was no difference ($P>0.05$) in post-exercise BUN (mg/dL) between VL (13.14 ± 1.33), L (15.27 ± 1.37), and C (16.83 ± 1.33). Post-exercise BUN (mg/dL) increased ($P<0.05$) in H (19.16 ± 1.33) and VH (20.20 ± 1.33) versus VL, L, or C diets. In summary, NR was maximized in horses fed 1016 g CP and BUN was minimized in horses fed 903 g CP. In conclusion, NR and BUN can be used to estimate the CP requirement for exercise in the mature horse, and yield close estimates of CP requirement.

Key Words: Horse, Protein, Exercise

86 The Effect of Prepartum Milking on the Health and Well Being of First Calf Heifers. K. J. Daniels*[1], J. R. Townsend[1], S. S. Donkin[1], S. D. Eicher[2], A. G. Fahey[1], and M. M. Schutz[1], [1]*Purdue University,* [2]*USDA-ARS*.

Transition heifers face multiple stressors around parturition, including first exposure to milking, that may compromise immune function and increase susceptibility to disease. Our objective was to determine the effect of prepartum milking (PM) of heifers on udder edema, presence of mastitis causing bacteria, calving parameters, heifer mobility and plasma haptoglobin (HAP) levels. Twenty-two primiparous heifers, blocked by expected calving date, were randomly assigned to either PM or control (CT). The PM heifers were milked twice daily beginning at 21 d before expected calving and CT heifers were not milked until after calving. Immediately prior to the third milking postpartum, milk samples were collected aseptically from each quarter and udder edema was quantified as the change in area (cm^2) between teats from blots obtained before and after milking. Blood was drawn on d 1, 3, 5, 7 and then weekly until d 56. Walking speed, a measure of mobility, was measured twice weekly as the length of time for a heifer to move between two points, for the first 28 d of lactation. The model selected for analysis included effects of block and treatment. The PM heifers had greater change in the area between teats (-51.6 cm^2 vs. -17.09 cm^2, PM vs. CT, P<.01), decreased HAP concentrations (2.46 mg/dL vs. 12.95 mg/dL, PM vs. CT, P<.01) on d 7, increased frequency of infected quarters (.306 vs. .089, PM vs. CT, P<.01) and decreased mobility, as measured by walking speed (4.7 s vs. 3.0 s, PM vs. CT, P<.05) at d 28. Calving parameters were not significantly affected by PM. Prepartum milking decreased udder edema and HAP concentrations, but increased the overall presence of mastitis causing pathogens and the length of time to move between two points. The data indicate that PM may offer an alternative management practice that has beneficial effects on udder edema and HAP concentrations, but is accompanied by decreases in mobility and increased presence of pathogens in the udder.

Key Words: Prepartum Milking, Heifers, Well Being

87 Computer simulation of the economics of swine insemination scenarios. K. A. Fischer*, T. J. Safranski, and W. R. Lamberson, *University of Missouri-Columbia*.

A stochastic simulation model has been developed to allow comparison of biological and economic efficiencies of scenarios of estrous detection and insemination of sows. The simulation consisted of 1500 herds of 100 sows bred under different scenarios to yield an economic return based on the conception rate (CR) and litter size (LS) of each individual sow. Conception rate and litter size were assumed dependent on time of insemination relative to ovulation, which in turn was dependent on weano-estrus interval. Economic return was the value of income from selling weaned piglets minus cost of producing a litter and cost of semen and labor for each scenario. Effects of once versus twice daily estrous detection were evaluated at intervals of: 24 h (S1), 12 h (S2), 8 and 16 h (S3), and 6 and 18 h (S4). Observations of commercial farms practicing twice daily estrous detection suggest that the afternoon check is often not as efficient as the morning check, so three additional scenarios were evaluated assuming a 70% efficiency of detection in the afternoon checks. Insemination was simulated one, two, three or four times for each heat check scenario resulting in 59 combinations. Greatest return ($84.79/sow) was from sows bred three times per day with S2. The added costs of labor and semen from a fourth insemination superceded the benefits of the higher LS and CR. The best two-insemination scenario, S1, had an economic return of $7.23/sow less than the optimum scenario; this might be offset if the cost of insemination was higher than that simulated ($10.93). The best single breeding schedule, sows bred 24 hours after first detection of estrus using S2, had a $17.43 lower return than the optimum scenario. Most heat check scenarios with 100% efficiency had higher return than scenarios with 70% efficiency. High economic return resulted from high conception rate, large litter size, precise estrous detection, and using resources such as labor and semen as efficiently as possible.

Key Words: Artificial Insemination, Computer Simulation, Sows

88 Effects of CIDR devices on follicular development and *in vitro* fertilization in anestrous ewes treated with melatonin and follicle stimulating hormone. J.S. Luther*, D.A. Redmer, L.P. Reynolds, J.T. Choi, D. Pant, C. Navanukraw, J.D. Kirsch, R.M. Weigl, K.C. Kraft, and A.T. Grazul-Bilska, *North Dakota State University*.

In a recent study from our laboratory (Luther et al., Biol. Reprod. 66, Suppl.1; 240, 2002), a combination of melatonin implants (Melovine®; 18 mg melatonin, Sanofi Sante Nutrition Animal, La Ballastiere, France) and controlled internal drug release (CIDR-Type G; 300 mg progesterone, Inter Ag, Hamilton, New Zealand) devices increased the number of developing follicles in follicle stimulating hormone (FSH-P with 10% luteinizing hormone; Sioux Biochemical, Sioux Center, IA, USA)-treated anestrous ewes; however, CIDR treatment decreased the rate of *in vitro* fertilization (IVF). In the current study, effects of alternative CIDR treatments on follicular development and rate of IVF in anestrous ewes was evaluated. On d -60 from oocyte collection (d 0) all ewes (1CIDR and 2CIDR treatment groups; n=6/group) received a melatonin implant. In addition, CIDR's were implanted on d -22 and removed on d -17. On d -10 2CIDR ewes received a second CIDR for 8 d (removed on d -2). All ewes received FSH injections twice daily on d -2 and d -1. On d 0, oocytes were aspirated from follicles, matured *in vitro* for 17-24 h and then subjected to IVF on d 1 of culture. 1CIDR and 2CIDR ewes had a similar (P > 0.10) number of follicles $\geq$ 1 mm in diameter (26.7 $\pm$ 8.6 and 24.3 $\pm$ 13.3, respectively) and rate of oocyte recovery (91.3 $\pm$ 3.5 and 99.3 $\pm$ 1.6%, respectively). On d 3 of culture, the rate of oocyte maturation (sum of fertilized and matured unfertilized oocytes [determined by DAPI staining]) was similar (P > 0.10) between 1CIDR and 2CIDR ewes (89.7 $\pm$ 7.4 and 87.6 $\pm$ 6.3%, respectively). However, oocytes collected from 2CIDR ewes had lower (P < 0.01) rates of IVF than oocytes collected from 1CIDR ewes (30.2 vs. 58.0%, respectively). Thus, IVF rates were adversely affected by an additional 8 d CIDR treatment. These data indicate that the interval between CIDR treatment and oocyte collection affects IVF rates in FSH-treated ewes during anestrous. Therefore, progestogen treatment protocols used in ovine IVF programs should be carefully designed to minimize adverse effects on fertilization rates.

Key Words: IVF, CIDR, Anestrous Ewe

Growth, Development, Muscle Biology, and Meat Science

89 Comparison of beef cattle ultrasound and carcass measures to predict percent retail product yield from the four primals. R. G. Tait,Jr*, D. E. Wilson, and G. H. Rouse, *Iowa State University, Ames IA*.

Retail product yield from the four primals is a very economically important trait 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 the carcass measures going into the USDA yield grade equation. This study utilized market cattle (n=471) 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; weights of each component were then recorded. Retail product 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^{th} rib fat thickness (CFAT), 3) 12-13^{th} rib ribeye area (CREA), and 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^{th} rib fat thickness (UFAT), 3) 12-13^{th} 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 stepwise regression was performed to develop models to predict percent retail product from the four primals based on carcass measures or ultrasound measures, and comparisons were made between the models. Significant measures (p<.001) for the carcass data were CFAT, KPH, and CREA with a model R^2 = .297. Significant measures (p<.001) for the ultra-

sound data were UFAT, UREA, SCANWT and URDEPTH with a model $R^2 = .448$.

Key Words: Beef, Ultrasound, Retail Product Yield

90 Body composition changes in Angus Bulls from weaning to yearling measured serially with real-time ultrasound. G. H. Rouse*, D. E. Wilson, J. R. Tait, A. Hassen, and A. G. Rouse, *Iowa State University, Ames, Iowa*.

The objective of this study was to evaluate body compositional changes in bulls from weaning to yearling. Bull calves born in the spring of 1999, 2000 and 2001 were fed a 61 Mcal diet from December to May, scanned, weighed and hip height measured approximately every 28 days. Compositional changes were determined by measuring subcutaneous fat cover (SFC) longissimus dorsi area (LDA) and percent intramuscular fat (PFAT) with a Classic Scanner 200 and an attached 18 cm, 3.5 MHz linear array transducer six times on each of 315 Angus bull calves. Models were developed using weight and age to predict rate of change for muscle and fat deposition from 273 kg to 545 kg or 220 to 400 days of age. Initially data were adjusted for year effect. Ultrasound data pooled within sex were analyzed using mixed model procedures that included fixed linear and quadratic effects of age and weight at measurement and random effects of animal.

Within a week of harvest mean live weight and age were 559.8±44 Kg and 400.0±21.1 days respectively. A comparison of final ultrasound scan (ULT) and carcass (CM) measurements are shown below.

SFC increased with increasing weight (P<.01) and age was nonsignificant while PFAT increased with age (P<.01) and weight was nonsignificant. LDA increased from weaning to yearling, both age and weight were significant (P<.01). During the 180 day scanning period rate of SFC deposition declined while rate of LDA increased and PFAT rate of deposition was static.

	ULT	CM	BIAS	SEP	r
SFC, cm	0.882±.287	0.967±.307	-0.033	0.086	0.73
LDA, cm^2	85.72±8.28	83.89±7.95	0.28	1.13	0.60
PFAT, %	4.20±1.01	3.88±1.35	0.31	0.96	0.70

Key Words: Beef, Ultrasound, Body Composition

91 Effects of cooking method, reheating, holding time, and holding temperature on beef longissimus lumborum and biceps femoris tenderness. E Obuz*, M.E Dikeman, and T.M Loughin, *Kansas State University*.

Effects of cooking method, holding temperature, holding time, and reheating on Warner-Bratzler peak shear force (WBPSF); Warner-Bratzler myofibrillar force (WBM-F), Warner-Bratzler connective tissue force (WBC-F) and cooking loss were investigated. Two muscles (longissimus lumborum and biceps femoris) from USDA Choice beef carcasses were used. Water-bath cooking resulted in higher WBPSF, WBM-F, and WBC-F than belt-grill cooking for longissimus lumborum. The biceps femoris muscle tenderness improved more with holding time after cooking on a belt than the longissimus lumborum due to its higher collagen content. Cooking biceps femoris steaks to 54°C by a belt grill and holding them at 54°C in a water bath for 15 min and subsequent reheating to 70°C (best treatment combination) produced a 25% reduction in WBPSF, a 37% reduction in WBC-F, and a 12% reduction in WBM-F as compared to the control (cooking steaks directly to 70°C without holding). Water-bath cooking resulted in lower WBPSF than belt-grill cooking for biceps femoris without any holding time, but further tenderization did not occur with holding. Water-bath cooking resulted in higher cooking losses than belt-grill cooking for both muscles.

Key Words: Cooking, Tenderness, Holding

92 Influence of treadmill exercise (TME) on meat quality of Holstein calves. C. B. Boger, J. K. Apple, E. B. Kegley, W. J. Roberts, T. J. Wistuba, D. L. Galloway, and L. K. Rakes, *University of Arkansas, Fayetteville, AR*.

Holstein steers (n = 25) were used to evaluate the influence of varying durations and speeds of TME on meat quality and formation of dark-cutting beef. Calves were blocked by weight and assigned within blocks to 1 of 5 treatments of a 2 x 2 factorial design with an unexercised control (NS). Calves were exercised at either 4 or 8 km/h for either 10 or 15 min, then immediately harvested. Blood samples were collected via indwelling jugular catheters at 10 and 2 min pre-exercise, at initiation of exercise (0-min), and at 2-min intervals during exercise and at harvest for quantification of serum cortisol, lactate, and glucose, and plasma NEFA. Upon completion of TME, calves were harvested, and longissimus muscle (LM) samples were removed from the right sides at 0, 1.5, 3, 6, 12, 24, and 48 h post-exsanguination for pH determinations. After a 48-h chill at 1C, subjective and objective color measurements of the LM were obtained, and samples of LM were used to measure bound (BNDMST) and expressible moistures (EXPMST) using the Carver press methodology. There was no effect (P > 0.10) of TME on serum cortisol levels until 6 min after the initiation of exercise. At harvest calves that were exercised at 8 km/h had increased (P < 0.05) serum cortisol levels when compared to the control and calves that exercised at 4 km/h. Calves that were exercised at 8 km/h had elevated (P < 0.05) serum lactate concentrations at every time point after the initiation of exercise, when compared to the control and calves that exercised at 4 km/h. However, TME did not affect (P > 0.30) postmortem pH decline, and had no (P ≥ 0.29) effect on LM color or moisture content. Even though TME elicited a noticeable stress response, this physical stressor failed to produce dark-cutting beef.

		10 min		15 min		
Item	NS	4.0 km/h	8.0 km/h	4.0 km/h	8.0 km/h	P <
Color score [a]	4.9	4.8	5.0	4.6	4.5	0.39
CIE L∗	40.0	40.4	39.7	41.5	41.9	0.28
CIE a∗	11.8	11.8	11.5	11.9	10.9	0.66
CIE b∗	13.5	13.7	13.3	14.1	13.7	0.53
Moisture, %	76.6	76.4	76.6	77.1	76.7	0.50
BNDMST, %	56.7	57.0	58.5	55.3	56.6	0.80
EXPMST, %	43.3	43.0	41.5	44.7	43.4	0.80

[a]1 = pale, grayish pink to 6 = dark purple

Key Words: Calves, Exercise, Meat Quality

93 Effects of restraint and isolation stress on stress physiology and the incidence of dark-cutting longissimus muscle in Holstein steers. C. B. Boger, J. K. Apple*, E. B. Kegley, W. J. Roberts, T. J. Wistuba, D. L. Galloway, and L. K. Rakes, *University of Arkansas, Fayetteville, AR*.

Thirty-two Holstein steers, weighing approximately 136 kg, were used to test the effects of varying durations of restraint and isolation stress (RIS) on endocrine and blood metabolite status, and the incidence of dark-cutting longissimus muscle (LM). Calves were blocked by weight, and assigned randomly within blocks to one of four treatments: unstressed controls, or 2, 4, or 6 h of RIS. Blood samples were collected via indwelling jugular catheters, 40, 20, and 0 min pre-stressor application and at 20-min intervals during RIS, and unstressed calves remained in their home stanchions and were subjected to minimal handling and stress. Serum cortisol, as well as plasma glucose and lactate, concentrations were elevated (P < 0.01) in RIS-calves, regardless of stressor duration, compared with their unstressed counterparts. Insulin concentrations were similar among treatment groups during the first 80 min after stressor application, but, from 100 to 340 min, calves subjected to RIS had greater (P < 0.01) insulin concentrations than unstressed calves. In the LM, 24- and 48-h pH values were in excess of 6.0, and higher (P < 0.01) in calves subjected to 6 h RIS than unstressed controls and calves subjected to 2 or 4 h RIS. Total moisture in the LM was similar among treatment groups. However, calves subjected to 6 h RIS had greater (P < 0.01) bound moisture and lower expressible moisture than unstressed controls and calves subjected to 2 or 4 h RIS. In the LM, CIE L∗ values were reduced (P < 0.01) in RIS-calves, regardless of stressor duration, compared with their unstressed counterparts. Seventy-five percent of carcasses from calves exposed to 6 h of RIS were deemed to be dark-cutters; whereas, only 25% of carcasses of calves subjected to 2 or 4 h RIS, and no controls, were classified as dark-cutters. Therefore, subjecting young, lightweight Holstein steers to 6 h of RIS may be an effective, reliable, animal-model to study the dark-cutting condition.

Key Words: Calves, Stress, Meat Quality

94 Effect of pig age at market weight and magnesium supplementation through drinking water on pork quality. B. R. Frederick*, E. van Heugten, and M. T. See, *North Carolina State University, Raleigh, NC.*

Thirty-two halothane negative pigs (108±0.6 kg BW) were used to determine the effect of age of pig and magnesium supplementation through drinking water on pork quality. Two initial groups of 50 pigs that differed by 30 d of age were fed diets to meet or exceed nutrient requirements from 28 kg BW. Sixteen pigs were selected from each group, individually penned, provided 2.7 kg of feed (0.12% Mg) daily, and allowed free access to a nipple waterer for the duration of the study. After 7 d of adjustment, pigs were randomly allotted by sex and weight to 0 or 900 mg/L of supplemental Mg as $MgSO_4$ in drinking water 2 d prior to harvest. All 32 pigs were then transported (110 km) to a commercial abattoir on the same day and harvested 2.5 h after arrival. *Longissimus dorsi* (LD) and *Semimembranosus* (SM) chops were packaged and stored to simulate display storage for fluid loss and Minolta color determination at 0, 4, and 8 d. Two remaining sections of the LD were vacuum-packed and stored at 4°C for 25 or 50 d. Fast (younger) and slow (older) growing pigs differed by 27 days of age, 153 and 180±0.4 d (P<0.001) at 108 and 109±0.4 kg BW (P>0.20), respectively. Purge loss, color, or oxidation of vacuum-packed LD or SM nor oxidation or fluid loss of displayed LD and SM were affected by age of pig or Mg supplementation (P>0.10). Surface exudate, measured by filter paper, of the SM from older pigs was less than younger pigs, 61 vs 74±6 mg (P<0.05). Surface exudate of the LD was not affected by age of pig, 58 vs 73±7 mg (P>0.10), respectively. The LD from older pigs displayed for 4 and 8 d had lower L∗ than younger pigs, 51.9 vs 53.7±0.7 (P<0.05) and 54.4 vs 55.6±0.6 (P<0.06). The SM from older pigs had lower L∗ after 8 d, 54.4 vs 56.0±0.4 (P<0.05), and tended to have higher a∗ after 4 and 8 d of display storage, 9.7 vs 9.2±0.4 and 9.4 vs 8.8±0.4 (P<0.10), respectively. Magnesium had no effect on pork quality. However, the SM from older pigs had less exudate, tended to be redder, and the LD and SM from older pigs were darker than younger pigs.

Key Words: Pork Quality, Magnesium, Water

95 The effects of Paylean on growth, carcass and meat quality traits of Berkshire and Yorkshire progeny. M.J. Ritter*, C.P. Allison, N.L. Berry, R.O. Bates, G.M. Hill, and M.E. Doumit, *Michigan State University.*

An experiment consisting of two replicates was conducted to determine the effects of Paylean on growth, carcass and meat quality traits of Berkshire- (B) and Yorkshire- (Y) sired progeny. At approximately 82 kg live weight, barrows (n = 56) were blocked by litter, live weight, ultrasound tenth rib backfat and loin muscle area and were assigned to one of four treatments: Berkshire-sired control (BC), Berkshire-sired fed Paylean (BP), Yorkshire-sired control (YC) and Yorkshire-sired fed Paylean (YP). Paylean was fed at 10 ppm in a 16% crude protein and 0.9% lysine corn-soybean meal diet for the last four weeks of the finishing phase. Paylean did not affect average daily feed intake, average daily gain or live weight at harvest, but YP had higher feed efficiencies than YC (P<.03). Paylean did not affect hot carcass weight or carcass backfat thickness of BP or YP in comparison with their respective controls. Carcasses from BP had larger loin muscle areas (P<.02) and more kg of fat-free lean (P<.05) than BC. Additionally, Paylean increased trimmed loin weights in B and Y carcasses (P<.03) and YP carcasses had heavier picnic shoulder weights than YC (P<.05). Significant treatment by breed by replicate interactions (P<.05) existed for loin muscle 1 h and 24 pH and d 1 CIE L* values. Also, loin muscle from BP had higher 30 min temperatures than BC (P<.04). However, these interactions and differences in carcass temperature appear to be of little practical importance as Paylean did not affect water-holding capacity or subjective color, firmness and marbling of fresh loin chops from B and Y. In conclusion, 10 ppm of Paylean for the last four weeks of the finishing phase improved lean yield of B and increased trimmed loin weights of B and Y, yet had no effect on fresh pork quality traits.

Key Words: Paylean, Carcass Traits, Pork Quality

96 Local variation in glycolytic potential, pH, and pork quality traits in the longissimus dorsi of pigs. T.M. Bertol*[1,2,3], M. Ellis[1], M.J. Ritter[1], and D.N. Hamilton[1], [1]*University of Illinois at Urbana-Champaign,* [2]*Empresa Brasileira de Pesquisa Agropecuaria - Brasil,* [3]*Conselho Nacional de Desenvolvimento Cientifico e Tecnologico - Brasil.*

This study was carried out to evaluate variation in glycolytic potential (GP), pH, and quality traits in the longissimus dorsi (LD) of slaughter weight pigs (118 9.5 kg). Twenty-four hours postmortem the LD was removed from both sides of 18 carcasses between the 6th rib and 6nd lumbar vertebrae. A 5-cm section was discarded from each end of the LD, and the remaining portion was divided in seven 5-cm sections for the determination of Minolta L∗, a∗, and b∗, pH, and subjective color, firmness, and marbling. Each section was divided into 3 chops which were used for the determination of drip loss, GP, and Warner-Bratzler shear force, respectively. Marbling and ultimate pH were similar (P > 0.05) in all locations. Subjective color and firmness increased (P < 0.01) while drip loss, L∗, and a∗ decreased (P < 0.01) from the anterior to the posterior end of the loin ([1.9^c, 2.0^c, 2.3^b, 2.6^a, 2.7^a, 2.7^a, and 2.6^a; 0.14 SEM], [1.9^d, 2.5^c, 3.1^b, 3.5^a, 3.6^a, 3.6^a, and 3.6^a; 1.82 SEM], [7.7^a, 7.6^a, 6.5^b, 6.1^b, 5.9^b, 5.9^b, and 6.0^b% ; 0.37 SEM], [51.7^a, 51.7^a, 50.3^c, 48.4^e, 48.7^{de}, 48.6^{de}, and 49.6^{cd}; 0.53 SEM], and [8.7^a, 8.3^b, 8.1^{bc}, 7.7^d, 7.8^{cd}, 7.8^{cd}, and 8.0^{bcd}; 0.25 SEM], resp.). Glycogen, lactate, and GP were higher (P < 0.01) in samples from the middle of LD than the extremities ([18.3^c, 19.9^{ab}, 20.5^a, 20.5^a, 20.8^a, 20.6^a, and 19.3^b μmol/g; 1.71 SEM], [95.1^c, 97.5^{ab}, 98.4^a, 97.9^{ab}, 97.9^{ab}, 97.7^{ab}, and 96.7^b μmol/g; 1.40 SEM], and [131.7^c, 137.4^{ab}, 139.5^a, 138.8^a, 139.5^a, 138.9^a, and 135.3^b μmol/g; 2.89 SEM], resp.). Minolta b∗ values were lower (P < 0.01) in the middle sections of the LD than at the extremities (6.0^a, 5.3^{bc}, 5.1^{cd}, 4.2^f, 4.5^{ef}, 4.8^{de}, and 5.5^{abc}; 0.21 SEM). The results of this study suggest that meat quality traits and GP vary throughout the LD. Therefore, when performing repeated measures in the loin it is necessary to consider this variation in quality attributes.

Key Words: Longissimus, Glycolytic Potential, Pork Quality

97 Effect of supplementary magnesium and preslaughter handling on blood acid-base responses in finishing pigs. D. N. Hamilton*[1], M. Ellis[1], and T. M. Bertol[123], [1]*University of Illinois at Urbana-Champaign,* [2]*Empresa Brasileira de Pesquisa Agropecuaria - Brasil,* [3]*Conselho Nacional de Desenvolvimento Cientifico e Tecnologico - Brasil* .

Preslaughter handling of pigs may influence the animal's physiological responses, and ultimately can influence pork quality. Thus, the objective of this study was to determine the effects of a magnesium-fortified diet (Mg) on changes in the blood acid-base status in response to different preslaughter handling intensities. Forty pigs were used in a 2x2x2 factorial with the treatments being: 1) Diet (control [0 g] vs 3.2 g of Mg pig-1 d-1), 2) handling intensity (low vs high), and 3) gender (barrows vs gilts). Pigs were fed the diets for five-d and baseline meaures of blood parameters and live weight (118±1.8 kg) were collected two-h before pigs were subjected to the handling protocol, which consisted of moving the pigs through a passage (12.2 x 0.91 m) for a total of 8 laps. Pigs on the high intensity treatment were moved rapidly through the passage and received 2 shocks/lap from an electric goad while pigs on the low intensity moved at their own pace with the aid of a livestock panel and paddle. Animals fed the Mg diet had lower blood PO_2 (38.4 vs 47.0, SE = 2.64 mm Hg, P = 0.03) than controls, however, no other differences were found for baseline values. Post-handling, pigs fed the Mg diet had lower lactate (9.4 vs 11.4, SE = 0.82 mmol/L, P = 0.04) than controls. Animals on the high compared to the low intensity handling treatment had higher blood lactate (16.6 vs 4.2, SE = 0.82mmol/L, P < 0.001) and rectal temperatures (39.8 vs 39.6, SE = 0.08°C, P < 0.01) with lower blood pH (7.10 vs 7.34, SE = 0.020, P < 0.001), HCO_3^- (21.8 vs 33.5, SE = 0.93 mmol/L, P < 0.001), and base excess (-7.9 vs 9.2, SE = 1.50 mmol/L, P < 0.001). Gender had little effect on blood acid-base measurements post-handling; gilts had lower base excess (-1.6 vs 2.9, SE = 1.50 mmol/L, P = 0.04) with a tendency (P = 0.11) for lower pH and HCO_3^- values than barrows. Results from this study highlight the major impact of pig handling intensity on blood acid-base balance and suggest that dietary supplementation with Mg did not moderate the effects of handling on blood acid-base status.

Key Words: Magnesium, Acid-base, Preslaughter Handling

98 Characterization of color uniformity of the cut lean surface in fresh ham. M. T. See* and B. A. Belstra, *North Carolina State University, Raleigh NC.*

Data were collected on fresh hams to evaluate quality characteristics across groupings with decreasing uniformity of visual color. Carcasses were identified and hot carcass weight (87.8 kg), fat depth and loin depth were collected at 45 m postmortem from pigs representing nine producer lots. Hams were fabricated under normal commercial conditions at 24 h postmortem. Hams were visually classified as normal (n = 140), slightly two-toned (n = 77), moderately two-toned (n = 29) or two-toned/PSE (n = 13). Ultimate pH, Minolta L* value, and fluid loss were measured on the cut lean surface of the gluteus medius, psoas major and quadriceps femoris. As a check on visual classification, color difference was calculated for each ham as the sum of the squared deviations of the Minolta L* value of each muscle from the average Minolta L* value of all three muscles. Hot carcass weight, fat depth, and ham weight did not differ ($P > 0.05$) across color classifications. However, loin muscle depth increased linearly (55.2, 54.3, 57.9, 57.3 ± .8; $P < 0.01$) with decreasing color uniformity. Calculated color difference was in strong agreement with visual color classification showing a linear increase (53, 74, 92, 106 ± 7; $P < 0.001$) as visual uniformity decreased. For the quadriceps femoris, ultimate pH decreased linearly (6.01, 5.96, 5.96, 5.86 ± .03; $P < 0.05$), and Minolta L* value (52.5, 54.2, 54.8, 58.3 ± .6; $P < .001$) and fluid loss percentage (2.1, 2.5, 3.1, 3.3 ± .2; $P < 0.001$) linearly increased with decreasing uniformity of color in the ham face. Likewise for the gluteus medius, ultimate pH decreased linearly (5.92, 5.87, 5.84, 5.75 ± .02; $P < 0.001$), and Minolta L* value (47.8, 49.0, 51.8, 55.2 ± .7; $P < 0.001$) and fluid loss percentage (2.6, 2.8, 3.5, 3.8 ± .2; $P < 0.001$) linearly increased with decreasing uniformity of color in the ham face. However, no differences ($P > 0.05$) were observed across color classifications for ultimate pH, Minolta L* value or fluid loss percentage of the psoas major. These results indicate that differences in color uniformity are more closely related to quality differences of the gluteus medius and the quadriceps femoris than the psoas major.

Key Words: Pork, Quality, Color

99 Effects of dietary electrolyte balance on blood acid-base balance in finishing pigs. D. N. Hamilton*[1], M. Ellis[1], and T. M. Bertol[1,2,3], [1]*University of Illinois at Urbana-Champaign,* [2]*Empresa Brasileira de Pesquisa Agropecuaria - Brasil,* [3]*Conselho Nacional de Desenvolvimento Cientifico e Tecnologico - Brasil* .

Loss of animals during transport and poor meat quality are interrelated issues that are associated with stress leading to metabolic acidosis. Thus, the objective of this study was to determine the effects of dietary electrolyte balance (DEB) on blood acid-base parameters in pigs subjected to a high intensity handling model. Thirty pigs were used in a completely randomized design with the following three DEB ($Na^+ + K^+ - Cl^-$ meq/kg) treatments: Low (-38 meq/kg; 1.15 % $CaCl_2$) vs Control (122 meq/kg) vs High (326 meq/kg; 2.5 % $NaHCO_3^-$). Pigs were given a one-week period to acclimate and were then fed the DEB diets for a period of five d. Baseline measurements of blood acid-base parameters and live weight (113.9 ± 2.10 kg) were collected two-h before the handling procedure, which consisted of moving each pig individually through a passage (12.2 ± 0.91 m) for a total of eight laps and with each pig receiving 2 shocks/lap from an electric livestock goad. Control and High DEB treatments had greater ($P < 0.05$) baseline TCO_2, HCO_3^-, and base-excess while tending ($P = 0.06$) to have lower rectal temperature when compared to Low DEB pigs. Baseline blood pH showed a quadratic response ($P = 0.01$); as pigs fed the Control DEB diet had greater ($P < 0.03$) blood pH than pigs fed the Low DEB diet, while pigs on the High DEB diets were intermediate and similar to both. Levels of TCO_2, HCO_3^-, and base-excess increased linearly ($P < 0.02$) as DEB level increased. Post handling, blood pH was greater ($P < 0.05$) for pigs on the Control and High DEB diets when compared to the pigs on the Low DEB diet. Base excess was lowest for pigs on the Low DEB diet and highest for the pigs on the High DEB diet, while pigs on the Control DEB diet were intermediate and similar to the both. Furthermore, post-handling levels of TCO_2, pH, HCO_3^-, and base-excess increased linearly ($P < 0.05$) as the DEB level increased. In conclusion, these data indicate that feeding a low DEB diet increases handling-induced acidosis owing to a decrease in blood pH, base-excess and HCO_3^-.

Key Words: Pigs, Acid-base, Handling

100 Growth, carcass and bone integrity of pigs fed conjugated linoleic acid during the early finishing phase. B. R. Wiegand*, M. A. Fritsch, B. M. Kolb, and J. A. Robb, *Illinois State University Normal, IL/USA.*

The main objective of this study was to determine if a performance advantage could be gained by supplementing pigs with conjugated linoleic acid (CLA) during the high growth phase of grow-finish swine production. Dietary CLA was fed (0.6 % of the total diet) to crossbred (Large white× Landrace × Duroc) growing-finishing pigs (n=48). Diets were isocaloric and CLA replaced soy oil in the control diet. Pigs started the trial at an average body weight of 40.4 kg and remained on experimental diets until 30 d prior to slaughter (93 kg body weight). All pigs were fed the control diet for the remaining 30 d period. Pigs were humanely slaughtered at an average body weight of 116.5 kg. Growth performance, carcass, and bone integrity data were collected and statistically analyzed according to a 2 × 2 factorial arrangement within a randomized complete block design. Pigs were randomly assigned to control or CLA diets by sex and blocked on litter. Gilts fed CLA exhibited higher ($P < 0.05$) ADG compared with gilts fed the control diet (0.84 kg/d vs. 0.80 kg/d). All pigs fed CLA had lower ($P< 0.04$) last rib fat depth compared with pigs fed the control diet (2.54 cm vs. 2.31 cm). Dexascan measurements of bone mineral density (BMD) and bone mineral content (BMC) of the femur revealed no differences ($P = 0.23$ and $P = 0.38$, respectively) when comparing all pigs fed CLA with all pigs fed the control diet. While some advantages in performance and carcass traits were realized in this trial, the removal of CLA in the diet 30 d prior to slaughter negated expected growth performance and carcass trait improvements reported in previous studies.

Key Words: Swine, Linoleic Acid, Bone Integrity

101 Effects of dietary inclusion level of manganese on live swine performance and quality characteristics of longissimus muscle (LM) chops during retail display. W. J. Roberts[1], J. K. Apple*[1], C. V. Maxwell[1], C. B. Boger[1], K. G. Friesen[1], T. M. Fakler[2], and Z. B. Johnson[1], [1]*University of Arkansas, Fayetteville, AR,* [2]*Zinpro Corp., Eden Prairie, MN.*

To test the effects of dietary inclusion level of manganese (Mn) on performance and quality traits of LM chops during retail display, crossbred pigs (n = 212) were blocked by BW, assigned to pens (6 pigs/pen) within blocks, and pens (6 pens/block) were allotted randomly to either a corn-SBM starter (23.6 to 36.4 kg), grower I (36.4 to 68.2 kg), grower II (68.2 to 90.9 kg), and finisher (90.9 to 106.8 kg) diets with no supplemental Mn or diets supplemented with 20, 40, 80, 160, or 320 ppm of Mn from Availa®-Mn (Mn-amino acid complex). When the lightest block averaged 106.8 kg, pigs were harvested, and boneless pork loins were captured during fabrication. Loin chops were weighed, placed on foam trays, and overwrapped with PVC film for retail display (4C; deluxe warm white light; 1600 lx). On d 0, 1, 4, and 7 of display, subjective and instrumental color was measured, and chops were removed from packages and re-weighed to calculate moisture loss. Pigs fed 40, 80, and 320 ppm Mn consumed less ($P < 0.02$) feed than pigs fed unsupplemented diets or 20 ppm Mn during the starter phase. Although dietary Mn had no ($P > 0.71$) affect on performance during the early grower phase, pigs fed 40 and 320 ppm Mn had higher ADG and G/F than pigs fed the control diet or diets fortified with 20, 80, and 160 ppm Mn (cubic effect; $P < 0.02$ and $P < 0.06$, respectively) during the late grower phase. Across the entire trial, there was a trend (cubic effect; $P < 0.09$) for G/F to be higher in pigs fed diets containing 320 ppm than those fed the control diets or diets containing 20, 80, and 160 ppm Mn. Dietary Mn did not affect ($P \geq 0.18$) pork carcass composition or LM quality characteristics during retail display. Even though Mn supplementation had no appreciable effects on pork quality during display in the present study, results indicate that supplementing diets with 40 or 320 ppm Mn from Availa®-Mn may enhance pig performance, especially feed efficiency.

Key Words: Manganese, Performance, Pork Quality

102 Effects of ractopamine step-up programs on finishing pigs fed under commercial conditions. T.A. Armstrong*, T.A. Marsteller, B.T. Kremer, R.D. Muller, and J.E. Weatherford, *Elanco Animal Health, Indianapolis, IN*.

A total of 1050 pigs were used to determine the effectiveness of ractopamine (RAC; Paylean® , Elanco Animal Health) step-up programs in extending the RAC response when compared to a constant RAC feeding program. Pigs were housed in a commercial finishing barn with an average stocking density of 22 pigs/pen. Pens were randomly assigned to receive 1 of 4 dietary treatments, with 12 replications/treatment. Dietary treatments were: 1) control, no RAC; 2) 5.0 ppm RAC for 35d (Constant); 3) 5.0 ppm RAC for 14d, followed by 10.0 ppm RAC for 21d (Step1); and 4) 5.0 ppm RAC for 21d, followed by 10.0 ppm RAC for 14d (Step2). All dietary treatments were based on a basal diet that was analyzed to contain 18.1% CP and 1.0% lysine. Pen and feed weights were collected weekly from time of trial initiation (average BW = 78.5 kg), and pens were marketed after the 35d experimental period (average BW = 105.4 kg). Total weight gain, ADG, and feed efficiency were improved ($P < 0.01$) by RAC, and RAC step-up programs (Step1 and Step2) resulted in further improvements in these growth parameters ($P < 0.01$) compared to the Constant treatment; however, there were no differences ($P > 0.05$) in animal performance between Step1 and Step2. There were no effects ($P > 0.05$) of RAC, regardless of feeding program, on ADFI. Increases ($P < 0.02$) in hot carcass weight (HCW), loin depth, lean percent, total kg lean, percent yield, carcass grade, carcass value, and base meat price were achieved with RAC feeding. There was no effect ($P > 0.05$) of RAC on 10th rib fat depth. Implementing either Step1 or Step2 tended to increase ($P = 0.09$) HCW and carcass grade, and increased ($P < 0.05$) loin depth and total kg lean compared to the Constant treatment. No differences ($P > 0.05$) were evident for carcass measures between either step-up program. These data demonstrate the effectiveness of RAC in improving growth performance and carcass characteristics. In addition, RAC step-up programs were effective in extending the RAC response under commercial conditions.

Key Words: Ractopamine, Growth, Carcass

103 Performance and carcass effects of ractopamine fed to finishing pigs in commercial conditions. G Armbruster[1], T Marsteller[1], T Armstrong*[1], E Berg[2], J Wagner[1], R Muller[1], and J Weatherford, [1]*Elanco Animal Health, Indianapolis, IN,* [2]*University of Missouri, Columbia, MO*.

A total of 2911 pigs, in three separate commercial research facilities, were used to determine performance and carcass benefits of finishing pigs fed ractopamine (RAC; Paylean®, Elanco Animal Health). Different genetic sources were used at each site. Each barn was double curtain sided, and housed 1000 to 1200 finishing pigs. Pen size varied between sites, but was identical within a site. Stocking density was typical of modern production (19 to 30 pigs/pen). Pigs were blocked by gender and weight, and pens within a barn were randomly assigned to 1 of 4 dietary treatments (0, 5, 10, or 20 ppm RAC), with 32 reps/treatment. Pigs on all treatments received meal diets containing a minimum of 16% CP and 1.0% lysine. Treatments were administered for 28 days beginning at an average body weight of 85 kg and ending at 110 kg. On d 28, one pig, representative of other pigs in a pen (within 5 pounds of average pen weight on both d 0 and d 28), was selected for carcass evaluation. Data were analyzed by pre-planned single degree of freedom orthogonal contrasts. Contrasts were: 0 vs 5 and 10 ppm RAC, 5 vs 10 ppm RAC, and 10 vs 20 ppm RAC. Total gain, ADG, and gain:feed were improved ($P < 0.01$) by RAC. RAC decreased ($P < 0.01$) ADFI and improved ($P < 0.01$) gain:feed in a dose dependent manner. Gain:feed was improved by 14.9, 17.3, and 20.1%, and ADG was improved by 11.5, 12.6, and 14.2% at 5, 10, 20 ppm RAC, respectively. RAC increased ($P < 0.01$) chilled carcass weight, and the following deboned, trimmed primal weights were increased ($P < 0.05$) by RAC: ham, loin, tenderloin, boston butt, and picnic. There was no impact ($P = 0.36$) on loin marbling, and RAC, at 5 and 10 ppm, had no effect ($P = 0.47$) on color. Trimmed, deboned ham, loin, and tenderloin weights were improved ($P < 0.04$) by 5 and 10 ppm RAC when compared to 0 ppm. These data demonstrate the beneficial effects of RAC on growth performance and carcass characteristics.

Key Words: Ractopamine, Carcass, Growth

104 Finishing performance and ultrasound composition of Paylean® supplemented pigs sorted into backfat thickness classes. K. J. Mimbs*[1], T. D. Pringle[1], S. A. Meers[1], M. J. Azain[1], and T. A. Armstrong[2], [1]*The University of Georgia, Athens, GA,* [2]*Elanco Animal Health, Greenfield, IN*.

This study was conducted to determine the response in animal performance and ultrasound fat and muscle measurements of pigs varying in prefinishing 10^{th} rib backfat to Paylean® supplementation. Crossbred barrows (n = 144) were assigned to a factorial arrangement with two backfat (BF) classes (fat, F vs lean, L) and two levels of Paylean® (PL; 0 vs 10 ppm). Pigs (80 kg) from four farrowing groups were ranked using ultrasound backfat and sorted into L and F groups (difference $\geq$ .5 cm). Selected pigs were penned by BF class and randomly assigned to PL treatment. Pigs were fed a corn/soybean diet containing 18% CP and 1.1% lysine for 28 d. Feed consumption, liveweight and ultrasound backfat (UBF) and Longissimus muscle area (ULMA) was recorded every 7 d. Data were analyzed using ANOVA for a replicated (n = 4), 2 x 2 factorial arrangement with the main effects of PL treatment and BF class and their interactions. Replicate and replicate interactions were included in the model to remove replicate variation. Pigs supplemented with PL had higher daily gain:feed (C = .36 vs PL = .38; $P < .01$), and lower daily feed intake over the 28 d study (C = 2.96 vs PL = 2.75 kg/pig/d; $P < .01$). Reductions in feed intake by PL versus C pigs were greatest during wk 3 and 4 of the study. Paylean® had no effect on ADG ($P > .05$). Neither BF class nor the interaction of BF class with PL treatment affected ($P > .05$) ADG, gain:feed or feed intake. As expected, L pigs had less UBF than F pigs (L = 1.89 vs F = 2.40 cm; $P < .01$). Treatment x time interaction for UBF was significant ($P < .03$) as PL supplemented pigs were significantly leaner than C pigs after 21 and 28 d. While BF class did not affect UBF accretion rates, UBF accretion was significantly slower in PL pigs (.011 cm/d) than C pigs (.017 cm/d). Lean pigs had larger ULMA than C pigs (L = 30.6 vs F = 29.1 cm^2; $P < .04$), and while ULMA accretion was not different across PL treatment, PL pigs tended ($P = .10$) to have larger ULMA than C pigs. Regardless of initial fatness, Paylean® improved gain:feed, primarily through reduced feed intake, and increased carcass lean of finishing pigs.

Key Words: Pork, β-Agonist, Growth

105 Carcass yield and quality traits of Paylean® treated pigs differing in prefinishing ultrasound 10^{th} rib fat thickness. K. J. Mimbs[1], T. D. Pringle*[1], M. J. Azain[1], and T. A. Armstrong[2], [1]*The University of Georgia, Athens, GA,* [2]*Elanco Animal Health, Greenfield, IN*.

This study was conducted to determine the effects of prefinishing backfat (BF) levels and Paylean® (PL) treatment on pork carcass yield and quality attributes. Crossbred barrows were assigned to a factorial arrangement with two BF classes (fat, F vs lean, L) and two levels of Paylean® (0 vs 10 ppm). Pigs (80 kg) from four farrowing groups were ranked using ultrasound BF and sorted into L and F groups (difference was $\geq$ .5 cm). Selected pigs were penned by BF class and randomly assigned to PL treatment. Pigs were fed a corn/soybean diet (18% CP; 1.1% lysine) for 28 d. After finishing, the two average gaining pigs from each pen were harvested (n = 56). Following a 48 h chill, carcass fat (last rib; 10^{th} rib, TRIB and last lumbar vertebrae, LLV); muscle (longissimus area, LMA, and depth, LED; and USDA muscle score, CMS) and quality (marbling, color, firmness, L*, a*, b* and pHu) traits were measured. Data were analyzed using ANOVA for a replicated (n=4), 2x2 factorial arrangement with PL treatment, BF class and their interaction as main effects. Replicate and replicate interactions were included in the model to remove replicate variation. Hot carcass weight was not affected ($P > .10$) by PL or BF class. As expected, fat depths were lower ($P < .05$) in the L vs F pigs and TRIB was lower for PL vs C pigs (2.08 vs 2.29 cm, $P = .06$). Backfat and PL treatment interacted to affect LLV, with the L,C and L,PL pigs being leaner ($P < .05$) than the F,C pigs and the F,PL pigs being intermediate. The muscling measurements, LEA (45.9 vs 40.0 cm^2), LED (6.2 vs 5.5 cm), and CMS (2^+ vs 2) were greater ($P < .05$) for the PL vs C pigs and CMS was higher ($P < .05$) in the L vs F pigs. Backfat class did not affect ($P > .25$) quality measures and PL did not affect ($P > .3$) color or L*. Marbling ($P = .07$) and firmness ($P < .01$) scores and pHu (5.62 vs 5.53, $P < .01$) were higher for PL vs C pigs. Regardless of the BF levels prior to finishing, carcass composition of PL-fed pigs was improved, primarily through increases in muscling.

Additionally, carcass quality, based on marbling and firmness scores and pHu, was improved slightly with PL treatment.

Key Words: Pork, β-Agonist, Composition

106 Ractopamine may improve meat quality by altering postmortem metabolism. Q. Guo*[1], A.L. Grant[1], B.T. Richert[1], A.P. Schinckel[1], and D.E. Gerrard[1], [1]*Purdue University, West Lafayette, IN.*

Variation in pork quality represents one of the most important issues impeding increased export of US pork. Of particular concern is the incidence of pale, soft, exudative pork, which further exacerbates the normal variation in pork color. Pork quality development essentially is a consequence of the rate and extent of carbohydrate metabolism in muscle postmortem. Curiously, increased muscle growth has a negative impact on pork quality, yet numerous researchers report that ractopamine (RAC), a beta-adrenergic agonist that stimulates muscle growth, has no impact on pork quality. Therefore, the objective of this study was to determine the effect of feeding RAC to gilts on subsequent postmortem muscle carbohydrate metabolism. Gilts had ad libitum access to a 1.1% lysine commercial finishing diet containing RAC (20 mg/kg) for 0, 1, 2 or 4 wk prior to slaughter (12 gilts/time). Longissimus muscle samples were collected at 0, 30, 60, 90, 120 min, and 24 hr postmortem and snap frozen in liquid nitrogen. Muscle samples were powdered and glycogen, glucose-6-phosphate, glucose and lactate concentrations were determined. No differences were observed in any of the NPPC loin quality parameters investigated. Higher loin muscle pH values were noted ($P < 0.05$) at 10 min postmortem in pigs fed RAC for 1 or 2 wk, however, pH values at all other times were not affected by treatment. Compared to controls, pigs fed RAC for 4 wk had reduced ($P < 0.05$) muscle glycogen levels at all times postmortem. In addition, muscle glucose levels were greater ($P < 0.05$) in pigs feed RAC for 4 wk. Muscle lactate levels were reduced ($P < 0.05$) after feeding RAC 1 wk, whereas no reduction was observed in pigs fed RAC for 4 wk. These data show that increased time of feeding RAC results in altered muscle glycogen content and the ability of muscle to generate lactate, and suggest that RAC may improve pork quality by altering energy metabolism early postmortem.

Key Words: Ractopamine, Pork Quality, Glycogen

107 Relationships between environmental conditions on trucks and losses during transport to slaughter in finishing pigs. D. N. Hamilton*[1], M. Ellis[1], G. E. Bressner[1], B. F. Wolter[2], D. J. Jones[3], and L. E. Watkins[3], [1]*University of Illinois at Urbana-Champaign,* [2]*The Maschhoffs, Carlyle, IL,* [3]*Elanco Animal Health, Greenfield, IN.*

The objective of this study was to evaluate relationships between environmental conditions on a commercial livestock trailer and losses during transport from the farm to the packing plant. A total of 93 loads with 169 ± 11.2 pigs per load with a live weight of 128 ± 14.0 kg were evaluated. The trailer was divided into nine compartments and the pigs were loaded at a stocking density 0.47 ± 0.126 m^2/pig. Percent dead and subjects (pigs that were unable to walk, sustained an injury, or showed signs of exhaustion) on arrival at the plant was 0.19 ± 0.530 and 0.62 ± 0.979, respectively. Temperatures at the start and end of loading, halfway through the journey, on arrival at the plant, and at unloading were 16.6, 19.2, 19.7, 20.3, and 20.5°C, respectively (SE = 0.21; $P < 0.05$) and relative humidities were 72.7, 72.7, 64.8, 64.4, and 62.1 %, resp. (SE = 0.71; $P < 0.05$). Of all the factors evaluated, number of pigs per load was the most strongly correlated to the subjects, deads, and total losses (r = -0.23, -0.29, -0.27, resp.; $P < 0.05$). Average temperature during loading, transport and unloading was inversely correlated to the percentage of subjects and total losses (r = -0.20 and -0.15, resp.; $P < 0.05$). Average relative humidity during loading, transport and unloading was positively correlated to the percentage of subjects and total losses (r = 0.27 and 0.21, resp.; $P < 0.05$). Transport time was correlated with losses during transit (r = 0.30, 0.25, and 0.16, for subjects, deads, and total losses, resp.; $P < 0.05$). All of the correlations in this study were relatively low, indicating that there was no single factor responsible for the transport losses or that the issue may be caused by a combination of factors. Further research is warranted to evaluate other factors that may contribute to losses during transport.

Key Words: Pigs, Transport Losses, Temperature

108 Effects of removing slaughter weight pigs from single-sex pens on subsequent growth performance of finishing pigs. J. M. DeDecker*[1], M. Ellis[1], B. F. Wolter[1], B. P. Corrigan[1], S. E. Curtis[1], E. N. Parr[2], and D. M. Webel[2], [1]*University of Illinois at Urbana-Champaign,* [2]*United Feeds, Inc. Sheridan, IN.*

The objective of this study was to determine the effects of removal rate and sex (barrow vs gilt) on the performance of finishing pigs. Sixty single-sex pens of crossbred pigs (n = 1537) were used in a randomized complete block design with a 2 x 3 factorial arrangement of treatments. Factors included 1) sex (barrows vs gilts) and 2) removal rate (0, 12 and 24% of pigs removed). Pens (25 pigs; mean BW = 105.6 ± 0.37 kg) were randomly allocated to treatment, and the heaviest animals were removed as dictated by treatment. Floor and feeder spaces/pig were 0.64 m^2 and 2.7 cm, 0.72 m^2 and 3.1 cm, and 0.84 m^2 and 3.6 cm for the 0, 12 and 24% removal treatments, respectively. Two statistical analyses were conducted. The first compared 20-d growth performance between the entire group of pigs after removal (25 vs 22 vs 19 pigs/pen for the 0, 12 and 24% removal treatments, respectively). The second analysis compared the 20-d growth performance of the lightest 19 pigs in each treatment. Daily weight gain post-removal was similar ($P > 0.05$) for the 0, 12 and 24% removal rate treatments (792, 810, and 826 ± 26.6 g/d, respectively) as well as for the lightest 19 pigs (776, 819, and 826 ± 25.1 g/d, respectively). Therefore, the average weight of pigs produced decreased linearly ($P < 0.01$) as the percentage of the heaviest pigs/pen removed increased (121.1, 118.9, and 117.8 kg ± 0.84 for the 0, 12 and 24% removed treatments, respectively). The within-pen coefficient of variation for the entire group at d 20 post-removal decreased quadratically ($P < 0.05$) with increasing pig removal rate (8.74, 7.10, and 7.38 ± 0.293 for the 0, 12 and 24% removed treatments, respectively). Pens of barrows and gilts responded similarly to pig removal. Overall, barrows consumed more feed ($P < 0.001$), were heavier ($P < 0.001$), and had a lower ($P < 0.01$) gain:feed ratio than gilts. In summary, these results suggest that removing 12 or 24% of the heaviest pigs in pens averaging 105 kg BW does not impact the subsequent growth performance of the remaining barrows or gilts.

Key Words: Pigs, Removal, Sex

109 Effects of dexamethasone injection at birth on growth performance of pigs from birth to weaning. M. G. Young, M. D. Tokach, S. S. Dritz, R. D. Goodband, and J. L. Nelssen, *Kansas State University.*

A total of 82 litters were used in a 21-d study to evaluate the effect of injecting litters of pigs with dexamethasone on growth rate from birth to weaning. In dexamethasone treated litters, all pigs within a litter were administered 1 mg dexamethasone per pig intramuscularly when the litter was processed (within the first 24 h after birth). Control pigs were processed according to standard practice and did not receive a dexamethasone injection. The standard processing practices included clipping needle teeth, docking tails, notching ears, and intramuscular iron injection. Pigs were weighed at birth and weaning, and litter size within treatment was equalized after processing. There was no difference ($P > 0.28$) in sow weight change, litter growth rate from birth to weaning, mortality, or number of pigs weaned between pigs injected with dexamethasone compared to the control pigs. Administration of 1 mg/pig of dexamethasone within 24 hours of birth to whole litters of pigs did not improve pig performance from birth to weaning.

Item	Dexamethasone	Control	SEM	P<
Lactation length, days	20.8	21.0	0.71	0.60
Sow weight, kg				
Entry farrowing	237.0	246.6	4.35	0.26
Weaning	227.2	231.2	4.15	0.55
Loss	9.8	15.4	2.70	0.28
ADFI lactation, kg	5.8	6.0	0.18	0.46
Number of pigs				
Day 1	10.0	10.0	0.40	0.95
Weaning	9.1	9.1	0.31	0.97
Preweaning mortality, %	8.7	8.3	1.56	0.85
Piglet weight, kg				
Birth	1.50	1.51	0.07	0.93
Weaning	6.67	6.68	0.48	0.95
Piglet ADG, kg	0.235	0.231	0.01	0.67

Key Words: Dexamethasone, Pigs, Growth

110 Effects of dietary energy density and frame size on the concentration of plasma leptin and insulin of feedlot steers. C. C. Ribeiro-Filho*[1], A. H. Trenkle[1], D. D. Loy[1], D. H. Keisler[2], and P. M. Dixon[1], [1]*Iowa State University, Ames,* [2]*University of Missouri, Columbia*.

Circulating plasma leptin and insulin concentrations are dependent on the degree of fatness and energy intake of cattle. A feedlot trial was conducted to evaluate the effects of dietary energy concentration and animal frame size on plasma concentration of leptin and insulin of beef steers. Thirty-six steers with average weight of 325 kg were fed individually for 196 days. Treatments were composed of diets with energy concentration of 2.4, 2.7, or 3.0 Mcal of ME/kg of DM and animal frame size (small and large) by a 3 × 2 factorial design. Blood samples were taken by jugular venipuncture on days 0, 28, 56, 84, 112, 140, 168, and 196 for measurement of plasma leptin and insulin. Plasma leptin concentration was determined using a ruminant specific RIA, and plasma insulin concentration was determined using a commercial RIA kit. There was no significant (P>.05) effect of frame size on leptin concentration. The steers fed 2.7 or 3.0 Mcal/kg diets had significantly (P<.05) higher leptin concentration than those fed 2.4 Mcal/kg from day 84 to 168. At end of trial, plasma leptin concentrations were 10.2, 7.7, and 6.8 ng/mL for 3.0, 2.7, and 2.4 Mcal/kg diets, respectively, and the steers fed the 3.0 Mcal/kg diet had significantly (P<.05) higher leptin concentration than those fed the other two diets. Concentration of plasma insulin was significantly (P<.05) higher for small frame than large frame steers for days 112 and 140. There was no significant difference (P>.05) in plasma insulin concentration due to diets. Small frame steers fed the 3.0 Mcal/kg diet tended to have higher plasma leptin and insulin concentration than the other treatment combinations from day 84 to 196. The results indicated that plasma concentrations of hormones were affected by energy density of diet and frame size. These effects may be explained in part by the result of differences in body fatness related to diet and frame size.

Key Words: Leptin, Insulin, Cattle

111 Effects of adiposity and energy intake on plasma leptin concentration in beef cattle. C. C. Ribeiro-Filho*[1], A. H. Trenkle[1], D. D. Loy[1], D. H. Keisler[2], and P. M. Dixon[1], [1]*Iowa State University, Ames,* [2]*University of Missouri, Columbia*.

Leptin, a hormone produced by adipocytes, plays an important role in the regulation of feed intake and body composition. A feedlot trial was conducted to evaluate the effects of fat deposition and energy intake on plasma concentration of leptin in beef steers. Thirty-six steers with average weight of 325 kg were fed individually for 196 days. Dietary treatments were rations containing 2.4, 2.7, or 3.0 Mcal of ME/kg of DM. Daily dry matter and energy intake were measured. Blood samples were taken by jugular venipuncture on days 0, 28, 56, 84, 112, 140, 168, and 196 for measurement of plasma leptin. Plasma leptin concentration was determined using a ruminant specific RIA. Subcutaneous fat thickness (FT), the carcass measurement with the highest correlation to body fat, measurements were taken between the 12th and 13th ribs by ultrasound at the same days. Dietary treatments affected significantly (P<.05) dry matter intake during the late phase of the feeding period (after day 112), steers fed 2.4 or 2.7 Mcal/kg diets had greater DMI than those fed the 3.0 Mcal/kg diet. However, ME intake was not significantly (P>.05) different among treatments during this period. FT increased linearly as the steers progressed into feeding period, and those fed higher energy concentration diets tended to have higher FT than those fed lower energy concentration diets. Plasma leptin concentration was higher (P<.05) for steers fed the 3.0 or 2.7 Mcal/kg diet than those fed the 2.4 Mcal/kg diet during the late phase of the feeding period. FT and leptin concentration were positively and significantly correlated (r =0.33, P<.0001). These data suggested that leptin concentration in cattle may be more dependent on degree of fatness rather than dietary energy intake.

Key Words: Leptin, Adiposity, Cattle

112 Influence of weaning age and implant strategy on serum concentrations of leptin in beef cattle. D. L. McNamara*, E. L. McFadin, M. S. Kerley, D. H. Keisler, V. L. Pierce, T. B. Schmidt, C. A. Stahl, M. L. Linville, and E. P. Berg, *University of Missouri, Columbia, Missouri*.

In the cow calf industry, calf management strategies can affect producer profitability. Herein, the influence of calf weaning age on returns to the producer and calf performance was investigated. A specific objective within this study was to assess the relationship between live body composition and peripheral concentrations of leptin. Angus and Gelbvieh cross steers (n=136) were randomly assigned to a 2x2 arrangement of treatments consisting of: 1) early weaned calves implanted with 36 mg zeranol at weaning and reimplanted at 174d (EWI; weaning age=90 d; n=35), 2) early weaned calves not implanted (EWNI; weaning age=90d; n=34), 3) normal weaned calves implanted with 36mg zeranol at weaning (NWI; weaning age=200 d; n=33), and 4) normal weaned calves not implanted (NWNI; weaning age=200 d; n=34). All calves were weaned and acclimated to a traditional feedlot ration over a 21d period prior to the trial start date. Blood samples were collected from calves at trial start date and at 28d intervals thereafter to monitor serum concentrations of the adipocyte derived hormone leptin. Fat thickness (FT) and ribeye area (REA) measurements were obtained using ultrasound at 28d intervals. Pearson correlation coefficients were determined to assess the relationship between serum leptin and carcass compositional measurements. Weight of the steers at 200d of age accounted for a significant portion of the variation in serum leptin (p<0.001) such that the heavier steers had the greatest concentrations of leptin (r=0.43, p<0.0001). In addition, serum leptin was positively correlated with 12^{th} rib FT (r=0.58, p<0.0001) and REA (r=0.40, p<0.0001). Early weaned calves were heavier and had more serum leptin than NW calves (p<0.0001) at 200d of age. Presence or absence of zeranol implants did not affect serum leptin (p>0.1). These data provide evidence that leptin is positively correlated with fat mass in growing steers and that early weaned steers begin to deposit fat at an earlier age than normal weaned steers.

Key Words: Leptin, Early Wean, Beef

113 Localization of intermediate filament proteins in developing avian skeletal muscle cells. S. A. Lex, T. W. Huiatt, M. H. Stromer, and R. M. Robson*, *Iowa State University, Ames, Iowa*.

Intermediate filaments (IFs) are an integral part of the muscle cell cytoskeleton. In adult muscle cells, IFs function in the maintenance of cell integrity by linking Z-lines of adjacent myofibrils and by linking the Z-lines of the peripheral layer of myofibrils to the sarcolemma. Desmin is the major IF subunit protein in adult muscle cells. Synemin and paranemin are very large, novel IF proteins that are present in small amounts relative to desmin, but appear to function in linking IFs to other cytoskeletal components. To determine the order of expression, location and possible roles of these IF proteins in developing muscle, we used immunofluorescence and immunoelectron microscopy to localize these IF proteins in 12-day embryonic chick breast muscle cell cultures. After 1, 2, 4, 8 and 12 days in culture, cells were labeled with pairs of antibodies to the IF proteins or the Z-line protein α-actinin. Immunofluorescence demonstrated that paranemin was expressed earlier than either synemin or desmin as shown by the presence of myoblasts or early myotubes that were positive for paranemin, but not for either synemin or desmin, in 1- and 2-day cultures. At later stages of development, when all three proteins were expressed, paranemin, synemin, and desmin were colocalized, but paranemin labeling was more prominent at growth tips of elongating myotubes. Organization of all three IF proteins changed from a diffuse pattern at early stages to a longitudinal filamentous pattern. In 8-day cultures, the IF proteins began to colocalize with α-actinin at the myofibrillar Z-lines. In more mature myotubes in 12-day cultures, IFs were clearly localized at Z-lines, but paranemin expression was decreased relative to that of synemin. Immunoelectron microscopy clearly demonstrated localization of paranemin and synemin along IFs, located mainly near the ends of developing myofibrils and at cytoskeletal filament junctions. These results suggest that paranemin and synemin function in the organization of IFs in developing muscle cells, but appear to have distinct roles in IF organization. (Supported in part by USDA-NRICGP)

Key Words: Muscle Cell Cytoskeleton, Intermediate Filaments, Desmin

114 Comparison of performance, carcass traits, and economic returns of single versus reimplant strategies for finishing steer calves. J.D. Arseneau*[1], M.C. Claeys[1], J.W. Leininger[2], J.P. Hutcheson[2], and R.P. Lemenager[1], [1]*Purdue University, West Lafayette, IN,* [2]*Intervet Inc., Millsboro, DE.*

The objective of this study was to compare growth performance, carcass traits, and net return of finishing beef steer calves administered a moderate dose trenbolone acetate/estradiol combination implant as a single initial or re-implant strategy. Forty-eight British cross steer calves (initial BW 283.7 ± 6.8 kg) were randomly assigned by weight to one of four implant treatments: 1) no implant (CON), 2) Ralgro Magnum day 1 of the finishing period (MAG), 3) Revalor-IS day 1 (IS), or 4) Revalor-IS day 1 and day 80 (IS/IS). Steers were individually housed and fed a final finishing diet formulated for 13.0% CP and 1.38 Mcal NEg/kg DM. All steers were harvested after 165 d on feed. IS and IS/IS steers were 44.5 kg heavier ($P<0.05$) than CON steers at harvest, whereas final weights for MAG were intermediate and not significantly different ($P>0.05$) than IS, IS/IS or CON. For the overall 165 d feeding period, IS and IS/IS steers gained 9% and 18% more ($P<0.10$) per day than MAG and CON, respectively, and were 11.5% more efficient ($P<0.05$) than CON steers. MAG steers had 8% higher ($P<0.10$) daily gains than CON steers, however, feed conversions were not different between MAG and CON. Hot carcass weights were 32.4 kg and 29.8 kg heavier ($P<0.05$) for IS/IS and IS, respectively, compared to CON. Hot carcass weights did not differ between implant treatments. No statistical differences were detected for other carcass traits, including yield grade and quality grade distributions. Feed cost/.45 kg gain and total cost/.45 kg gain were identical for IS and IS/IS treatments ($0.25 and $0.38, respectively), and were lower ($P<0.10$) than CON ($0.29 and $0.43) and MAG ($0.27 and $0.41). Non-implanted cattle returned a respectable $76.55/head, however, implanting resulted in significantly higher ($P<0.10$) net returns over CON steers (range of $33.41 to $58.39/head higher than CON). These results demonstrate that either a single initial or reimplant program using Revalor-IS will improve ADG compared to either no implant or a zeranol implant. Carcass quality traits were not negatively affected by implanting in this study. Additional studies with greater animal numbers should be conducted to more thoroughly determine and document the economic affects of reimplanting with Revalor-IS.

Key Words: Beef Cattle, Finishing, Implant

115 Cow muscle profiling: Comparison of processing traits and shear forces of 21 muscles from beef and dairy cow carcasses. M.L. Buford*[1], C.R. Calkins[1], D.D. Johnson[2], and B.L. Gwartney[3], [1]*University of Nebraska-Lincoln,* [2]*University of Floriday, Gainesville,* [3]*National Cattlements's Beef Association, Denver, CO.*

Previous research has revealed that 43% of the cow carcass is sold as boxed beef. Much of the rest is merchandised as beef trim for grinding and processing. Opportunities may exist to add value into underutilized muscles from beef and dairy cows currently sold as boxed beef. To identify differences in composition of muscles from beef and dairy cows, 21 muscles from each of 74 carcasses (harvested from 4 geographic locations in the U.S. over a five-month period) weighing 249.7 to 340.7 kg were examined for various processing traits. Carcasses were selected based on body type (beef and dairy), twelfth- rib fat thickness (< 2.5 mm or > 2.5 mm), muscling level (heavy/medium or light), and skeletal maturity (C/D or E) and fabricated into denuded Adductor, Biceps femoris, Complexus, Deep pectoral, Gluteus medius, Infraspinatus, Latissimus dorsi, Longissimus dorsi, Multifidus/Spinalis dorsi, Psoas major, Rectus femoris, Semimembranosus, Semitendinosus, Serratus ventralis, Supraspinatus, Tensor fascia latae, Teres major, Triceps brachii, Vastus intermedius, Vastus lateralis, and Vastus medialis muscles. Muscles from 3/5 of the carcasses were used for determination of composition (% fat, moisture and ash), pH, expressible moisture (WHC, by centrifugation), objective color (L∗, a∗ and b∗), heme-iron, and total collagen. On muscles from 2/5 of the carcasses, Warner-Bratzler shear force (WBSF) values (dry heat cooked to 71 C; 1.27 cm cores) were measured. The data were analyzed to determine significant differences between traits for specific muscles from beef and dairy type carcasses. Beef muscles had a higher percent moisture (9 of 21 muscles), exhibited a darker color (lower L∗ for 4 of 21 muscles), and were less tender (higher WBSF for 4 of 21 muscles) than muscles from dairy carcasses ($P < 0.05$). Significant differences were found less frequently for percent fat (2 of 21 muscles), heme-iron (1 of 21 muscles), expressible moisture (1 of 21 muscles), total collagen (1 of 21 muscles), and percent ash (1 of 21 muscles). These data indicate that, other than percent moisture, only minor differences exist between muscles from beef and dairy cow carcasses of similar weight.

Key Words: Muscle Characteristics, Compostition, Dairy and Beef

116 Mathematical modeling of cooking longissimus lumborum and biceps femoris steaks. E Obuz* and M. E Dikeman, *Kansas State University.*

Modeling studies of meat cooking have gained popularity because they provide greater understanding of the dynamics of meat cooking. The objectives of our study were to model cooking time and temperature histories for longissimus lumborum and biceps femoris steaks. Each biceps femoris (n=10) and longissimus lumborum (n=10) steak was cooked in a gas-fired, forced-air convection oven at 163C individually until the center temperature of a steak reached 70C. Temperature histories for each steak were recorded by a Doric temperature recorder and the recorded time and temperature data were imported into a spreadsheet. A model was developed to predict cooking time and temperature histories for each steak. No significant differences ($P<0.05$) were found in cooking times between experimental and model values for either longissimus lumborum or biceps femoris steaks. Modeled temperature histories were consistently higher than the experimental values up to 65C in the cooking cycle for biceps femoris steaks, whereas a better agreement between experimental and modeled values was found for longissimus lumborum. A highly positive linear relationship was found between experimental and modeled temperature histories for both longissimus lumborum (R^2 = 0.99) and biceps femoris (R^2= 0.96) steaks. The developed model might be useful for cooking steaks for a constant time to a given degree of doneness and might increase consumer satisfaction by reducing variation in degree of steak doneness.

Key Words: Modeling, Cooking, Heat Transfer

117 The effects of cattle gender on feedlot performance, carcass characteristics and muscle tenderness. W. T. Choat*[1,2], J. A. Paterson[1], G. C. Smith[2], B. Rainey[1], M. King[1], and R. J. Lipsey[3], [1]*Montana State University, Bozeman,* [2]*Colorado State University, Fort Collins,* [3]*American Simmental Association, Bozeman, MT.*

Rate of gain, carcass traits and beef tenderness of 202 progeny of Angus or Simmental sires were compared. Steers (N=99), heifers (N=57) and intravaginally spayed heifers (N=46) were commercially fed (161 d). No implants were administered and heifers were not fed melengestrol acetate to control estrus. Strip loin sections from each carcass were aged for 7, 14 or 21d. Steaks (2.54cm) were cooked to an internal temperature of 70 °C and four to eight cores from each steak were sheared once using an Instron® 3100, fitted with a Warner Bratzler shear head. Data were analyzed using the GLM procedure of SAS. Steers had faster ($P < 0.01$) rates of gain than spayed and intact heifers. Heavier ($P < 0.01$) final live weights of steers resulted in 25 kg heavier ($P < 0.01$) hot carcass weights at similar ($P = 0.86$) levels of fat thickness compared with heifers. Spayed heifers had a 5.7% smaller REA ($P < 0.05$) compared with steers and intact heifers which were similar. Calculated yield grades and USDA quality grades were similar ($P = 0.21$) among treatments, although marbling scores were lower ($P < 0.01$) for steers compared to intact and spayed heifers. Shear force values after 7 d of aging were lower ($P < 0.01$) for steers (3.32) compared to intact and spayed heifers (3.77 and 3.56) which were not different. A similar response ($P < 0.01$) was also measured after 14 d for steers (3.29) compared to intact (3.62) or spayed heifers (3.52). Results revealed that intact and spayed heifers with comparable marbling had greater ($P = 0.05$) shear force values after 7 and 14 d of aging compared with steers. Under the genetic and environmental conditions of this experiment, steers had faster daily gains and produced heavier carcasses at similar levels of subcutaneous fat compared to heifers. Intact and spayed heifers produced strip loin steaks that had higher average shear force values (e.g., were less tender) than those from steers.

Key Words: Steers, Heifers, Shear Force

118 Effect of flax supplementation and growth promotants on steady-state lipoprotein lipase and glycogenin mRNA concentrations in finishing cattle. A. T. Waylan*, J. P. Kayser, J. D. Dunn, E. K. Sissom, and B. J. Johnson, *Kansas State University, Manhattan*.

Dietary triacylglycerols are packaged into chylomicrons and are stored on the inner surface of the capillaries in skeletal muscle and adipose tissue. Lipoprotein lipase (LPL) hydrolyzes triacylglycerols into monoacylglycerol and fatty acids, which are taken up by the tissues and utilized for energy. Glycogenin is the core protein upon which glycogen molecules are synthesized. There is one molecule of glycogenin per molecule of glycogen in skeletal muscle therefore glycogen storage is limited by the amount of glycogenin. The objective was to investigate the effect of feeding flax, a source of polyunsaturated fatty acids, and administering growth promotants on steady-state LPL and glycogenin mRNA content of muscle in finishing cattle. Sixteen crossbred steers (BW = 397 kg) given ad libitum access to a 93% concentrate diet for 28 d were used in a four-treatment, 2 x 2 factorial experiment with main effects of flax (non-flax or flax, 5% supplementation) and implantation (non-implant and implant of Revalor-S; 120 mg trenbolone acetate + 24 mg estradiol). Muscle biopsies were obtained from the longissimus muscle at 0, 14, and 28 d. Muscle samples were used to quantify LPL and glycogenin mRNA concentrations by using real-time quantitative PCR. Revalor-S did not affect LPL or glycogenin mRNA concentrations ($P \geq .13$). A day x flax interaction ($P \leq .0001$) was observed for both LPL and glycogenin mRNA concentrations. At 0 and 14 d, no differences ($P \geq .15$) were observed between non-flax and flax steers. At 28 d, non-flax steers had a 4.1 and 5.7-fold increase ($P < .0001$) over flax steers for LPL and glycogenin mRNA concentrations, respectively. These data suggest that flax supplementation to finishing steers for 28 d reduced gene expression of both LPL and glycogenin as compared to non-flax steers. Alterations in local concentrations of these two proteins could impact skeletal muscle's ability to utilize fatty acids and glucose for energy.

Key Words: Lipoprotein Lipase, Glycogenin, Beef Cattle

119 Evaluation of dexamethasone injection on preweaning growth performance of neonatal pigs under commercial conditions. A.M. Gaines*[1], J.A. Carroll[2], G.L. Allee[1], J. Connor[3], and D.C. Kendall, [1]*University of Missouri-Columbia,* [2]*Animal Physiology Research Unit, ARS-USDA,* [3]*Carthage Veterinary Service*.

Two commercial trials were conducted evaluating the use of dexamethasone (Dex) in improving preweaning growth performance of neonatal pigs. The objectives of the commercial trials were two-fold: To evaluate the sexual dimorphic growth response observed in a previous commercial trial and to determine whether there is any benefit of providing Dex treated pigs supplemental milk. In Exp.1, 703 pigs (TR-4 × PIC C-22) were assigned according to birth weight and sex to three treatments. Treatments included either an i.m. injection of saline (Control), Dex1 (1 mg/kg BW of Dex) or Dex2 (2 mg/kg BW of Dex) within 24 hr after birth. Birth weights (1.69 ± 0.01 kg) did not differ among treatment ($P = 0.96$) or between sexes ($P = 0.18$). No treatment effects were observed for BW at weaning ($P \geq 0.76$) or ADG ($P \geq 0.62$). The BW at weaning for Control, Dex1 and Dex2 treated pigs was 4.65 ± 0.06, 4.62 ± 0.06, and 4.59 ± 0.06 kg, respectively. The ADG of Control, Dex1 and Dex2 treated pigs were 230.6 ± 3.75, 225.8 ± 3.86, and 226.4 ± 3.82 g, respectively. In Exp. 2, 342 pigs (Genetiporc) were assigned according to birth weight and sex to two treatments. Treatments included either an i.m. injection of saline or Dex (2 mg/kg BW) within 24 hr after birth. All pigs were provided supplemental milk from the time of treatment until weaning age. Birth weights (1.58 ± 0.02 kg) did not differ among treatment ($P = 0.95$) or between sexes ($P = 0.10$). No treatment effects were observed for BW at weaning ($P \geq 0.19$) or ADG ($P \geq 0.13$). The BW at weaning for Control and Dex treated pigs was 5.09 ± 0.09 and 4.92 ± 0.09 kg, respectively. The ADG of Control and Dex treated pigs were 229.4 ± 5.28 and 218.1 ± 5.15 g, respectively. In contrast to our previous findings, Dex did not improve preweaning growth performance regardless of dosage or supplemental milk. Further studies are warranted to discern other factors encountered under commercial conditions that may influence growth responses observed with Dex treatment.

Key Words: Dexamethasone, Pigs, Growth

120 Effects of acute enteric disease challenge on the insulin-like growth factor system in nursery pigs. J. P. Kayser*, J. D. Dunn, A. T. Waylan, S. S. Dritz, J. C. Nietfeld, J. E. Minton, and B. J. Johnson, *Kansas State University, Manhattan*.

The goal of this study was to examine the effects of an acute Salmonella disease challenge on circulating IGF-1 and IGFBP-3 and steady-state IGF-1 and IGFBP-3 and -5 mRNA levels in skeletal muscle of nursery pigs. Weaned crossbred pigs (n=18, BW=11 kg) were blocked by weight into pens in an environmentally controlled nursery. Pigs had free access to water and were fed a standard corn-soybean meal diet free of added antimicrobials. After a 2 wk acclimation period, pigs received either one of two treatments (trt): 1) oral dose of $1.1x10^{10}$ CFU *Salmonella enterica* serotype typhimurium (ST, n=9) or 2) sterile broth (control, n=9). Serum was harvested from blood collected via jugular venipuncture and biopsies of the *gluteus medius* were obtained from all pigs on d 0, 3, 7 and 14 relative to ST-challenge. Serum IGF-1 and IGFBP-3 levels were determined by immunoassay. Total RNA was isolated from the muscle samples and real-time quantitative-PCR was used to evaluate differences in gene expression. ST-challenge reduced ($P < .05$) serum IGF-1 by 66 % on d 3 as compared to d 0. Sera from ST pigs had lower ($P < .05$) IGF-1 on d 3 and d 7 as compared to sera from control pigs (51% and 43%, respectively). No significant ($P > .10$) trt or trt x d interaction was detected for circulating IGFBP-3. However, serum IGFBP-3 levels were higher ($P < .01$) on d 7 and 14 as compared to samples on either d 0 or d 3. No trt or trt x d interaction ($P > .10$) was detected for muscle IGF-1 mRNA concentration. Muscle IGF-1 mRNA abundance was greater on d 14 than d 0, 3 or 7 (2.0, 2.8, 1.6-fold, respectively, $P < .01$). Muscle IGFBP-5 mRNA concentration was 2.2-fold higher ($P < .05$) on d 14 in control pigs as compared to ST pigs. No trt effect ($P > .10$) was observed for IGFBP-3 mRNA levels in muscle. These data indicate that acute enteric disease challenge affects circulating IGF-1 levels, but not local muscle IGF-1 mRNA levels in nursery pigs. Alterations in local IGFBP-5 mRNA levels may affect the bioactivity of IGF-1 in skeletal muscle.

Key Words: IGF-1, IGFBP, Pigs

121 Effect of conjugated linoleic acid on DNA fragmentation of preadipocytes in culture. K.M. Hargrave* and J.L. Miner, *University of Nebraska*.

Conjugated linoleic acid (CLA) reduces body fat and increases DNA fragmentation in fat pads of mice. CLA also reduces proliferating 3T3-L1 preadipocyte cell number and differentiating 3T3-L1 cell size and triglyceride content. The hypotheses were: (1) that CLA, and (2) that serum from mice fed CLA, can increase DNA fragmentation and reduce triglyceride content of 3T3-L1 cells. 3T3-L1 preadipocytes were plated in 12-well plates with DMEM and 10% calf serum plus 0, 50, 100, or 200 μM linoleic acid (LA) or CLA complexed to albumin (6.6:1), or 50 nM Staurosporine (4 wells per treatment). Media were changed every 2 d. Detached and attached cell number was determined during proliferation (2 d of treatment), confluence (4 d of treatment), and at three stages of differentiation (8, 10, and 12 d of treatment). Additional cells were supplied with DMEM containing 10% mouse serum from mice fed for 1 wk either a control (7% soy oil) or CLA (6% soy oil + 1% CLA) diet and cells were harvested at 2 d (proliferating) and 4 d (confluence). DNA fragmentation is expressed as the percent of fragmented to total DNA. Intracellular triglyceride content was determined enzymatically. Cell number was reduced ($P < 0.001$) in proliferating and confluent wells treated with 50 or 200 μM of either LA or CLA compared to the control. The 200 μM dose of each fatty acid also reduced ($P < 0.001$) cell number in the first stage of differentiation. The effect of CLA on cell number did not differ from the effect of LA at any stage. However, CLA caused an increase in DNA fragmentation compared to LA in proliferating ($P < 0.001$) and confluent ($P < 0.01$) cells (10.03 vs 1.72 and 3.61 vs 0.67% respectively), but not in differentiating cells. Triglyceride content was increased ($P < 0.01$) by both LA and CLA at the first stage of differentiation. CLA and LA caused a reduction in cell number, but only CLA caused an increase in DNA fragmentation. Interestingly, this increase was present only in preadipocytes, not in cells undergoing differentiation.

Key Words: Conjugated Linoleic Acid, DNA Fragmentation, 3T3-L1 Preadipocytes

122 Fibroblast growth factor receptor 1 mediates disuse atrophy in gastrocnemius and soleus muscles of mice. J.K. Eash*, A. Olsen, A.L. Grant, D.E. Gerrard, and K.M. Hannon, *Purdue University, West Lafayette, IN*.

Skeletal muscles exhibit atrophy following periods of reduced weight bearing. During this atrophy, there is an increased expression of fibroblast growth factor (FGF) in those fibers resistant to atrophy. Members of the FGF family are involved in muscle hypertrophy, however, their effects on muscle atrophy are not known. Therefore, the objective of this study was to determine if changes in FGF signaling alters muscle atrophy. The gastrocnemius and soleus muscles of the left limb of six mice were injected with plasmid DNA containing a cytoplasmic β-galactosidase (β-gal) reporter gene construct with a constitutively active (CMV) promoter (15 μg/limb). Contralateral limb muscles received the same reporter gene construct and 30 μg of plasmid DNA encoding fibroblast growth factor receptor 1 (FGFR-1). Limbs were then subjected to 16 pulses of 150 V of electricity using a pulse stimulator to facilitate plasmid uptake. Mice were randomly assigned to hindlimb suspension (HS) for 7 or 14 d. Another group was suspended for 7 d, then allowed to recover for 7 d. Muscle samples were collected, sectioned, and stained for β-gal. The cross sectional area (CSA) of β-gal positive fibers was determined using light microscopy and image processing software. After 7 d of suspension, β-gal fibers were 20.8 % larger ($P < 0.05$) in FGFR-1 injected muscles than contralateral controls. Similarly, β-gal positive fibers in FGFR-1 treated muscles of animals suspended 14 d were 17.9 % larger ($P < 0.01$) than contralateral muscles. In animals allowed to recover, fibers remained 13.9 % larger ($P < 0.01$) in FGFR-1 injected muscles than controls. These data suggest that fibers expressing FGFR-1 experienced less atrophy and exhibited improved muscle recovery, suggesting that elements of FGF signaling may mediate changes in protein metabolism during disuse atrophy.

Key Words: Muscle Atrophy, Fibroblast Growth Factor, Hindlimb Suspension

123 Regulation of Ankyrin Repeat and SOCS Box Protein (ASB) 15 mRNA Expression in Models of Skeletal Muscle Development. T.G. McDaneld*[1] and D.E. Moody[1], [1]*Purdue University,* [1]*Purdue University*.

Ankyrin repeat and SOCS box protein (ASB) 15 belongs to a family of genes characterized by the presence of both an ankyrin repeat and SOCS (suppressor of cytokine signaling) box motifs. Bovine ASB-15 mRNA was previously shown to be down-regulated in skeletal muscle in response to an anabolic compound. The objectives of this research were to further evaluate ASB-15 mRNA expression in additional models of muscle accretion and cell culture. Regulation of ASB-15 mRNA expression in response to various anabolic compounds was determined in rats. Thirteen 7-wk-old female rats were randomly assigned to each of four treatment groups: control, clenbuterol, trenbolone acetate (TBA), and growth hormone (GH). Changes in blood urea nitrogen (BUN) and ASB-15 mRNA expression were measured at 30 min, 12 h, and 24 h following intraperitoneal injections of each compound (50g/kg). Rats were humanly killed by CO2 asphyxiation prior to collection of blood and tissue samples. Clenbuterol treatment decreased ASB-15 mRNA expression in skeletal muscle at 12 and 24 h ($P<0.01$) and also decreased mRNA expression in lung at 12 h ($P<0.05$). BUN levels were also decreased for clenbuterol treated rats at 12 and 24 h ($P<0.05$) indicating an anabolic response corresponding to the decrease in ASB-15 mRNA expression. TBA treatment decreased BUN levels at 12 h ($P<0.05$), yet ASB-15 mRNA expression was not changed in any of the tissues evaluated ($P>0.10$). GH treatment had no effect on BUN or ASB-15 mRNA expression ($P>0.10$). Expression of ASB-15 mRNA was also measured in C2C12 myoblasts (day 0) and 1, 3, 5, and 7 days after induction of differentiation. ASB-15 mRNA expression increased with differentiation of myoblast to myotubes when compared to day 0 myoblasts ($P<0.01$). We conclude that ASB-15 mRNA is regulated by the anabolic compound clenbuterol and also differentiation of myoblasts. Our data, combined with previous reports of other ASB genes involved in progression of cellular growth, suggest that ASB-15 has a potential role in signaling pathways that regulate skeletal muscle development.

Key Words: Ankyrin, SOCS Box, Muscle Accretion

Nonruminant Nutrition

124 Effects of a growth-altering pre-pubertal feeding regimen on gilt growth and reproductive longevity. P. A. Lyvers-Peffer, J. J. Peng*, J. A. Snedegar, and D. W. Rozeboom, *Michigan State University, East Lansing*.

Two hundred fifty-four crossbred gilts were allotted to one of two rearing nutrition regimens (Moderate or Control) from 9 to 25 wk of age to determine the effects of a high-fiber diet fed intermittently on gilt growth and reproductive longevity. The Moderate regimen used dietary fiber to achieve alternating phases of moderate and maximum growth during four distinct pre-pubertal periods. High-fiber diets, containing 35% ground sunflower hulls, were fed during periods 1 and 3 (3 and 5 wk, respectively) to slow growth. During periods 2 and 4, low-fiber corn-soybean meal (CSBM)-based diets were fed for 3 and 5 wk, respectively, to maximize growth. Control gilts were fed CSBM-based diets in all periods to maximize growth. Ad-libitum access to feed was allowed at all times with both regimens. After 25 wk of age, both treatment groups were managed similarly. Average daily gain was lower ($P < 0.01$) for the Moderate gilts during periods 1 and 3, and greater ($P = 0.03$) for the Moderate gilts during period 4. Moderate gilts consumed more feed during period 4 ($P < 0.01$). During periods 1 and 3, feed efficiency was lower for Moderate gilts ($P < 0.01$). Plasma concentrations of IGF-1 were decreased for Moderate gilts during period 1 and the first wk of period 3 ($P < 0.01$ and $P = 0.03$, respectively). However, there were no differences in plasma IGF-1 concentrations during the last wk of period 3. At puberty, Moderate gilts weighed less than Control gilts ($P = 0.001$; 136.5 ± 1.56 versus 144.1 ± 1.74 kg), but age was similar. All subsequent measures of weight, backfat depth, and loin-eye area were similar. More ($P < 0.05$) Control gilts were culled during rearing and pre-breeding than Moderate gilts, with locomotive failure being the most prevalent reason. Of sows successfully completing parity one, 17% fewer ($P < 0.05$) Control females went on to complete three parities. Altering pre-pubertal growth of developing gilts by intermittent inclusion of dietary fiber may be beneficial in improving their reproductive longevity.

Key Words: Gilts, Fiber, Longevity

125 Efficacy of restricted/ad libitum feeding strategy for group-fed gilts during development. J. Klindt*, J. T. Yen, and R. K. Christenson, *USDA-ARS, U.S. Meat Animal Research Center, Clay Center, NE*.

Our previous studies, with gilts individually penned and feed-restricted during a 12-wk growth period prior to entering a breeding facility with *ad libitum* access to feed, showed that d to first estrus were least in gilts subjected to the most severe restriction during the development period. Herein, 180 gilts, 122 d of age and 75.6 kg BW, were assigned to 18 pens with 10 gilts/pen. Gilts were pen-fed to achieve 50%, 68%, and 88% of calculated *ad libitum* intake (treatment, trt). Diets were formulated to restrict only energy. At 221 d of age, gilts were moved to the breeding barn, repenned within trt, given ad libitum access to a common diet, and checked for estrus daily using mature boars. From 245 to 266 d of age, gilts were inseminated (AI) on 1st and 2nd d of estrus. During development period, 122 to 221 d of age, feed consumption was 1512, 2006, and 2647 kg/pen in the 50%, 68%, and 88% groups ($P < 0.01$), respectively. Trts influenced ($P < 0.01$) ADG and BW at 221 d of age; 0.330, 106.4; 0.506, 126.5; and 0.657 kg/d, 138.8 kg for 50%, 68%, and 88% trts, respectively. Within pen, SDs for ADG were not influenced by trt ($P > 0.15$). During breeding period, prior energy restriction induced compensatory feed consumption ($P < 0.09$): 1489, 1348, and 1198 kg/pen for 50%, 68%, and 88% trts, respectively. Total feed fed from 121 to 266 d of age was 3001, 3354, and 3854 kg/pen for 50%, 68%, and 88% trts ($P < 0.01$), respectively. Trts affected ($P < 0.01$) BW after AI or at 266 d of age; 134.6, 151.0, and 157.9 kg for 50%, 68%, and 88% trts, respectively. Treatments did not affect ($P > 0.38$) percentages acyclic, cyclic, and pregnant at 46 d after breeding: 10.0, 88.3, 76.7; 15.0, 80.0, 71.7; and 18.3, 78.3, 70.0; for 50%, 68%,

and 88% trts, respectively. Subjecting gilts to dietary energy restriction from 122 d of age until three wk before the start of mating, followed by *ad libitum* feed during breeding period, reduced total feed consumed and had no measurable impact on reproductive performance through 46 d after end of breeding.

Key Words: Gilts, Growth, Reproductive Performance

126 Effects of intrauterine location on fetal growth and development in the pig: nutritional implications. R. L. McPherson*[1], F. Ji[1], G. Wu[2], and S. W. Kim[1], [1]*Texas Tech University,* [2]*Texas A&M University.*

Three hundred and four fetuses from 25 primiparous sows were used in this study to determine fetal growth as related to fetal location within the uterine horn during gestation. All the sows were fed the same gestation diet at equal amounts (2.0 kg/d) and housed in crates during the trial. Sows were randomly assigned to slaughter groups representing days of gestation: 45 (6-sows), 60 (4- sows), 75 (3-sows), 90 (3-sows), 100 (5-sows), and 110 (4-sows). After slaughter, the reproductive tracts were obtained from all the sows and dissected to obtain the fetuses and the placentas. Before the dissection, the location of each fetus was recorded with the cranial extremity of each horn being location number one. The fetuses were further dissected to obtain individual organs: heart, liver, lung, gastrointestinal tract (GIT), spleen (75+ days), and kidneys. Overall, no relationship ($P > 0.05$) was found between fetal location and fetus weight on d 45, 75, 90 or 110 of gestation. However, there was a linear relationship between fetal location and fetus weight on d 60 and d 100 of gestation ($P < 0.01$), showing that the fetuses at the cranial extremities were proportionally larger than those at the caudal extremities of the uterine horn. When gestation day was not considered in analyzing the data, the weights of the fetus, fetal carcass, gastrointestinal tract (GIT), liver and kidney decreased linearly ($P < 0.01$), but the weights of the placenta, heart, lung and spleen decreased linearly ($P < 0.05$), as the location within the uterine horn proceeded cranial to caudal. These data suggest that the fetus at the cranial extremities of the uterine horn may receive more nutrient supplies than the fetus at the caudal extremities. In addition, the results suggest the availability of nutrients in sows on d 60 and d 100 of gestation may have a greater impact on fetal growth than at other gestational ages.

Key Words: Pigs, Intrauterine Location, Fetus

127 Changes of maternal tissues during gestation in primiparous sows: nutritional implications. F Ji*[1], Y. G. Kim[1], G. Wu[2], and S. W. Kim[1], [1]*Texas Tech University, Lubbock,* [2]*Texas A&M University, College Station.*

Thirty-five gilts (128.44±7.45 kg SE) were used to determine the weight changes of various body tissues of sows during gestation. Gilts were housed in individual gestation crates and were divided into two groups (heavy and light) based on BW. Three sows from each group were randomly selected and slaughtered to provide baseline information as day 0 of gestation. The remaining sows were bred and, within a group, randomly assigned to one of six slaughter groups: day 45 (6 sows), day 60 (4 sows), day 75 (5 sows), day 90 (4 sows), day 102 (5 sows) and day 112 (5 sows). All sows were fed 2 kg diet/d (3.115 Mcal ME/kg and 0.56% Lys) until the assigned slaughter d. Body weights of any remaining sows were measured on day 10, 25, 45, 60, 75, 90, 102, and 112 of gestation. The carcass, liver, stomach, small intestine, large intestine, spleen, pancreas, kidney, lung, heart, liver, uterus, mammary gland, and other remaining viscera were obtained, weighed, and ground for further analysis. The body weights and the weights of hot carcass, soft tissue (carcass without bone), bone, and the remaining viscera were increased linearly ($P < 0.05$) as gestation progressed. The proportion of hot carcass, soft tissue, bone, kidney, lung, and liver relative to the body weight was decreased linearly ($P < 0.0001$) as gestation progressed. The weights of stomach, small intestine, large intestine and pancreas, as well as the proportion of these organs relative to body weight were decreased linearly ($P < 0.001$) which might be due to restricted feeding during the gestation period. The weights of the reproductive tract (including fetuses) and average mammary glands were increased with gestation (quadratic, $P < 0.01$). Uterus weight and the proportion of the reproductive tract (including fetuses), fetus and uterus relative to body weight were increased linearly ($P < 0.01$). These data show that growth rates of maternal tissues in restrictedly fed sows vary greatly during gestation. Our findings may have important implications for establishing a feeding strategy for gestating sows to improve reproductive performance.

Key Words: Sows, Gestation, Tissue Growth

128 Apparent digestibility of soluble and insoluble fiber in diets for gestating sows. J. A. Renteria*[1], L. J. Johnston[2], D. D. Gallaher[1], and G. C. Shurson[1], [1]*University of Minnesota, St. Paul,* [2]*University of Minnesota, Morris.*

Twenty-four gestating sows (12 nulliparous, NULL; 12 multiparous, MULT) were fed four experimental diets to assess the apparent digestibility of soluble fiber (S) and insoluble fiber (IS). Experimental diets included corn-soybean meal control (C; 1.59% S, 7.67% IS), corn-soybean meal-34% oat bran high in S (HS; 3.19% S, 8.95% IS); corn-soybean meal-12% wheat straw high in IS (HIS; 1.46% S, 15.36% IS); and corn-soybean meal-16% sugar beet pulp (HS+HIS; 3.20% S, 15.31% IS). Sows were assigned randomly to diets within parity group, and individually fed to meet their energy requirements according to the NRC (1998) assuming 10 pigs per litter and 40-kg gestation gain. Total collections of feces and urine were conducted in 5-d periods at Wk 5, 10, and 14 of gestation. There were no parity group by diet interactions for any response criteria. Apparent digestibility of dietary S (83.8 vs 82.8%; $P > 0.20$) was similar between MULT and NULL sows, while IS digestibility was greater for MULT vs NULL sows (54.5 vs 51.6%; $P < 0.06$). Apparent S fiber digestibility was different among experimental diets (HS, 89.5%; C, 85.8%; HS+HIS, 80.3%; HIS, 77.7%; $P < 0.01$; SE= .84). Apparent IS digestibility was similar between HS+HIS and HS (61.9 and 58.4%), but greater than C (53.5%), while IS digestibility of HIS (38.3%) was lowest ($P < 0.01$; SE = 1.47). There was a time by treatment interaction ($P < 0.01$) for IS digestibility. Generally, digestibility of S improved ($P < 0.01$) as gestation progressed for sows fed C (82.6, 86.7, and 88.2%), HS (89.6, 89.9, and 89.1%), HS+HIS (74.8, 83.5, and 82.5%), and HIS (73.7, 76.9, and 82.5%). Digestibility of IS decreased as gestation progressed for sows fed C (57.6, 52.7, and 50.1%) and HS (67.5, 51.7, and 56.1%), but increased for sows fed HS+HIS (58.3, 64.3, and 63.0%), with no linear trend for sows fed HIS (40.5, 32.9, and 41.6%). In conclusion MULT had greater ability to digest IS than NULL. As gestation progressed, S digestibility improved. Digestibility of IS appeared to improve in the presence of S.

Key Words: Sows, Fiber, Digestibility

129 Comparison of three methods of feeding sows in gestation. M. G. Young*[1], M. D. Tokach[1], F. X. Aherne[2], R. G. Main[1], S. S. Dritz[1], R. D. Goodband[1], and J. L. Nelssen[1], [1]*Kansas State University, Manhattan,* [2]*Alberta Pig Company, Canada.*

A total of 689 sows were used to compare 3 methods of feeding during gestation. Control gilts and sows were fed according to body condition, based on a scale of 1 to 5 (1 = thin, 5 = fat). Feed allowance was arbitrarily set by the farm manager to achieve a body condition score of 3 at farrowing. For method 2, feeding level was based on backfat and weight (at weaning for sows or service for gilts). Feed allowance was modeled from calculations of weight and backfat gain to achieve a target backfat of 19 mm at farrowing with a constant feed allowance from d 0 to 101. Method 3 was similar to method 2, except feeding pattern was altered for thin sows and gilts (< 15 mm backfat at service) in an attempt to reach 19.0 mm backfat by d 36 of gestation. Sows were weighed at weaning (gilts at service) and at entry to the farrowing house (d 112 to 114 of gestation). Backfat was measured between d 0 to 5 and d 108 to 113 of gestation. Sows fed by methods 2 and 3 had achieved backfat of 19.0 and 19.1 mm at farrowing, respectively, while control fed sows numerically tended to have greater ($P < 0.11$) backfat at farrowing (19.9 mm). Control sows had greater backfat gain in gestation (3.6 mm, $P < 0.05$), than those fed using method 2 (2.6 mm), while sows fed with method 3 had intermediate backfat gain (3.0 mm). Control sows had greater weight gain in gestation (49.6 kg, $P < 0.05$) than sows fed with method 2 and 3 (42.3 kg). Sows targeted to gain 6 and 9 mm of backfat in gestation failed to achieve target gains regardless of feeding method. Feeding sows in gestation based on backfat resulted in a higher proportion of sows in the target backfat range (17 to 21 mm) at farrowing and a lower percentage of fat sows (> 21 mm backfat), but no difference in the percentage of thin sows (< 16 mm backfat) compared to the standard method of feeding based on body

condition. The higher proportion of sows in the optimum backfat category demonstrates that feeding based on backfat and body weight has the potential for facilitating more precise gestation feeding.

Key Words: Sows, Feed Intake, Backfat

130 Effect of gestation feeding method on sow performance in lactation.

M. G. Young*[1], M. D. Tokach[1], F. X. Aherne[2], R. G. Main[1], S. S. Dritz[1], R. D. Goodband[1], and J. L. Nelssen[1], [1]*Kansas State University, Manhattan,* [2]*Alberta Pig Company, Canada*.

A total of 562 sows were used to examine the effect of 3 gestating feeding methods on lactation performance. Control gilts and sows were fed according to a standard 5-point visual body condition score (1 = thin, 5 = fat). Feed allowance was arbitrarily set by the farm manager to achieve a body condition score of 3 at farrowing. For method 2, feeding level was based on backfat and weight (at weaning for sows or service for gilts). Feed allowance was modeled from calculations of weight and backfat gain to achieve 19.0 mm backfat at farrowing with a constant feed allowance from d 0 to 101. Method 3 was similar to method 2, except feeding was altered for thin sows and gilts (< 15 mm backfat at service) in an attempt to reach a target of 19.0 mm backfat by d 36 of gestation. Sow weight and backfat was recorded at entry into the farrowing house (d 108 to 113 of gestation) and at weaning. Lactation feed intake, total number of pigs born, born alive, born dead, mummified, fostered, and weaned were recorded. Dates of weaning and estrus were recorded to calculate wean-to-estrus interval. Performance in lactation and wean-to-estrus interval were not affected ($P > 0.10$) by gestation feeding method. Sow weight at farrowing, weaning, and lactation weight loss were not different ($P > 0.20$) among the three feeding methods. Lactation ADFI was not affected by gestation feeding method. The relationship between weight gain in gestation and lactation feed intake was highly variable with weight gain only explaining 9% of the differences in lactation feed intake. However, when comparing lactation ADFI for the high backfat sows (> 23 mm) to the rest of the population ($\leq$ 23 mm), a tendency ($P < 0.06$) was observed for high backfat sows to have lower ADFI in lactation (5.6 vs 5.9 kg). Total number of pigs born, born alive, born dead, mummified, and fostered pigs were not affected by gestation feeding method. The results indicate that the gestation feeding methods used in this trial had no effect on performance in lactation.

Key Words: Sows, Feeding Method, Lactation

131 Effect of dietary levels of soluble and insoluble fiber on litter size and sow performance.

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Three concurrent experiments involving 716 sows were conducted to evaluate the effects of soluble (S) and insoluble (IS) dietary fiber during gestation on litter size and sow performance. Sows were assigned randomly to a common control diet or a high fiber diet within each experiment. In Exp. 1, diets included a corn-soybean meal control (C; 1.54% S, 7.97% IS; n = 122) or corn-soybean meal-30% oat bran high in S fiber (HS; 3.18% S, 8.03% IS; n = 124). In Exp. 2, diets included C (n = 97) or corn-soybean meal-13% wheat straw high in IS fiber (HIS; 1.41% S, 15.63% IS; n = 119), and in Exp. 3, sows received C (n = 123) or corn-soybean meal-21% soy hulls (HS+HIS; 2.99% S, 20.80% IS; n = 131). Experimental diets were offered to sows to supply similar daily amounts of ME (6172 kcal), protein (250 g), and lysine (12 g) beginning two d post-mating. All sows, regardless of treatment, had ad libitum access to a standard lactation diet. The HS diet compared with C supported more sow wt gain during gestation (26.7 vs 16.1 kg; $P < 0.01$), but had no effect ($P > 0.30$) on total litter size born (11.15 vs 11.37 pigs), litter weaning wt (48.39 vs 49.09 kg), or ADFI of lactating sows (5.26 vs 5.45 kg). The HIS diet compared with C had no effect ($P > 0.20$) on sow wt gain during gestation (16.9 vs 13.4 kg), total litter size born (11.44 vs 11.32 pigs), litter weaning wt (54.8 vs 55.2 kg), or ADFI of lactating sows (6.01 vs 6.02 kg). The HS+HIS diet compared with C supported less sow wt gain during gestation (18.5 vs 28.6 kg, $P < 0.01$), and greater ADFI of lactating sows (6.20 vs 5.66 kg, $P < 0.01$), but had no effect ($P > 0.30$) on total litter size born (11.94 vs 12.27 pigs) or litter weaning wt (51.8 vs 53.2 kg). Post-weaning interval to estrus averaged 6.4 d and was not affected ($P > 0.15$) by dietary treatments. In conclusion, gestation diets high in soluble and(or) insoluble fiber can be fed at recommended energy and nutrient intakes without compromising sow or litter performance.

Key Words: Sows, Fiber, Litter Size

132 Full-Fat canola seed as an energy substitute for vegetable oil in late gestation and lactation diets.

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A total of 143 litters from 94 mixed parity sows were used to evaluate litter performance, sow body condition change, days to estrus, milk composition, and litter weights, when sunflower oil (SA) or full-fat canola seed (CA) were added to the control (C) diet of corn-soybean meal. Sows were randomly assigned to diets at day 100 of gestation. Sows were weighed and measured for body condition change using realtime ultrasound on day 100 of gestation, farrowing, day 7 and weaning. Milk samples were taken from three randomly selected sows per treatment per farrowing. Milk samples were analyzed for solids, protein, and fat at d 0 and 14. Litter weights were taken on d 0, 1, 7, and at weaning. SA sows returned to estrus earlier than C sows (4.60 vs. 5.25; $P < 0.07$). Sows on SA and CA diets weaned heavier litters than C sows (55.14, 53.37 vs. 49.44 kg; $P < 0.02$). The C and SA sows consumed more feed from d 100 to 0 than CA sows (39.25, 39.94 vs. 37.33 kg; $P < 0.03$). From d 0 to 7 SA sows ate more than sows on C and CA treatments (36.65 vs. 33.46, 32.78 kg; $P < 0.05$). Sows on SA and CA diets consumed more feed than sows on diet C between d 7 and weaning (58.12, 59.51 vs. 51.77 kg; $P < 0.02$). Overall feed intake showed SA sows consumed more feed than C sows (135.3 vs. 124.5 kg; $P < 0.03$). Milk collections taken on d 0 showed no differences between treatments, however, sows on SA diet had a higher butterfat content than sows on diets C and CA at d 14 (9.06 vs. 7.55, 7.86; $P < 0.03$). Sows on the SA diet also had a higher milk solids content on d 14 than sows on diets C and CA (19.61 vs. 18.24, 18.56; $P < 0.02$). Differences in survival rateof nursing piglets among treatments were not observed (88.96, 92.55, and 90.14%). There are benefits of increasing the fat content of late gestation and lactation diets for increased litter performance, and a quicker return to estrus. However, the cost of fat sources must be considered in determining the potential for these inclusions.

Key Words: Full-Fat Canola, Sow Performance, Milk Composition

133 Threonine is more limiting than valine in diets of lactating sows with high body protein loss.

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The objective of this study was to determine whether threonine or valine is more limiting in corn-soybean meal diets fed to lactating sows mobilizing a high amount of body protein, using plasma urea nitrogen concentration (PUN) as an indicator of amino acid limitation. The study was conducted as a replicated 4 X 4 Latin Square with three squares. Initial sow BW averaged 241 kg and initial litter size averaged 9 pigs. A diet containing corn and soybean meal as the only protein sources formulated to 0.90% lysine was diluted with starch, sucrose and soybean oil to lower the protein concentration and induce a high rate of body protein loss. L-lysine·HCl and D,L-methionine were added at 0.112 and 0.016% of the diet, respectively, to ensure that lysine and methionine were not limiting. From this basal diet, each of the following dietary treatments was formulated: 1) the negative control (NC) basal diet, 2) the NC diet supplemented with 0.139% L-threonine (NC+T), 3) the NC diet supplemented with 0.174% L-valine (NC+V), 4) the NC diet supplemented with 0.139% L-threonine and 0.174% L-valine (NC+T+V). Dietary treatments were made isonitrogenous by glycine supplementation. The study was initiated on either d 3, 4, or 5 of lactation for each sow. Feed intake was standardized to 4.8 kg/d, an amount of feed that did not exceed sow appetite, yet provided sufficient energy intake (18 Mcal ME/d). Each diet was fed to each sow for a period of four days. At the end of each period, blood samples were collected 5 to 6 h postprandial for analysis of PUN. The PUN was lower ($P < 0.01$) for the threonine-supplemented treatments, and was not affected ($P < 0.10$) by supplemental valine intake (see Table). Total sow BW loss and litter gain averaged 19.58 and 35.05 kg, respectively, for the entire 16-d study. This study demonstrates that threonine is more limiting than valine in corn-soybean meal diets fed to lactating sows with a high rate of body protein loss in lactation, when PUN is used as an indicator.

Diet	NC	NC+T	NC+V	NC+T+V	SEM
PUN, mg/dl	6.43	5.18	6.62	5.33	0.40

Key Words: Sows, Lactation, Limiting Amino Acids

134 Sow and litter responses to dietary organic or inorganic selenium over four parities.

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Ninety crossbred (L × Y) gilts evaluated the effects of Se source and levels on sow reproductive performance, and the Se status of the sow and litter. Experimental diets contained inorganic or organic Se (0.15 or 0.30 ppm Se) in a 2 × 2 factorial. A fifth group was fed an equal combination of the Se sources to 0.30 ppm Se. In addition, a basal non-Se fortified diet (0.06 ppm Se) served as a negative control. Diets were C-SBM based and met 1998 NRC nutrient requirements, except for Se. Six treatments were fed to each of three groups over a four parity period. Sows were bled at 70, 110 d postcoitum and at weaning with serum Se and glutathione peroxidase (GSH-Px) determined. Milk was collected at farrowing and weaning from all sows. Blood Se and serum GSH-Px activity were determined from three weanling pigs/litter. Data were analyzed as a repeated measures design. Sow and litter served as the experimental unit. Total and live pigs born were lower ($P < 0.07$) when the basal was fed. There was no increase in litter size beyond 0.15 ppm Se. Organic and inorganic Se resulted in similar sow and litter performances, except that fewer sows fed the 0.30 ppm Se diets completed the study. There was a trend ($P < 0.07$) for sows fed 0.30 inorganic Se to have more spraddle-legged pigs. Sows fed 0.30 ppm Se had higher serum Se ($P < 0.01$) but similar serum GSH-Px levels as 0.15 ppm Se; both being higher than the basal. Sows fed the combination of Se sources had serum Se and GSH-Px values similar to sows fed other 0.30 ppm Se diets. Colostrum and milk Se concentrations were higher ($P < 0.01$) when organic Se was fed, while feeding the combination of Se sources had colostrum and milk Se concentrations similar to the 0.15 ppm organic Se. Weaning pig serum Se increased as the sow Se level increased but GSH-Px activity values were similar when sows were fed 0.15 or 0.30 ppm Se. These results indicate that reproductive performance of sows can be attained with 0.15 ppm Se from either Se source, but the Se status of the sow and weaned pig was higher with 0.30 ppm Se from organic Se.

Key Words: Selenium, Reproduction, Sows

135 Available phosphorus requirements for finishing pigs reared in a commercial facility.

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We conducted an experiment in a commercial research barn to determine the appropriate dietary P level for pigs from 88 to 109 kg BW. We utilized 1,260 gilts allotted by weight to one of five dietary treatments. There were 28 pigs/pen and 9 pens/treatment. The corn-soybean meal-based diets contained 6% added fat and were formulated to 0.80% total lysine. Available P levels were 0.05, 0.10, 0.14, 0.19, or 0.23% which correspond to 0.152, 0.277, 0.402, 0.527, or 0.652 g aP/Mcal ME. A constant Ca:P ratio (1.1:1) was maintained in all diets. At the conclusion of the experiment, two pigs from each pen where randomly selected, tattooed, and slaughtered to obtain third and fourth metacarpals (MC3 & MC4) which were used to determine bone properties. From d 0 to 14, ADG increased linearly ($P < 0.01$; 621, 683, 691, 734, and 707 g/d) and gain/feed increased (linear $P < 0.02$; 0.325, 0.342, 0.344, 0.361, 0.361) with increasing aP. For d 14 to 26 or overall, there were no differences in growth performance between treatments ($P > 0.17$). For bone properties, MC3 bending moment increased (linear, $P < 0.01$; 100.2, 110.3, 118.4, 112.9, and 120.0 kg-cm) with increasing aP; however, bending moment was not different for MC4 ($P > 0.59$). The percentage ash increased, (linear, $P < 0.01$) for both MC3 (50.1, 50.7, 51.9 52.0, and 52.1%) and MC4 (51.2, 51.6, 51.8, 52.7 and 53.3.%) with increasing aP. Using the repeated measures analysis of SAS for combined MC3 and MC4; bending moment and percentage ash increased (linear, $P < 0.04$ and $P < 0.01$, respectively). Results from this study demonstrate the need for supplemental P in the final finishing diets of pigs raised in a commercial facilities. Using the result from this experiment and data presented last year [JAS 80(Suppl 2): Abstr.# 177] , a regression equation ($0.0000316*(\text{wt, kg})^2 - 0.00745*(\text{wt, kg}) + 0.95$) was developed to estimate the aP:Mcal ME ratio for pigs reared in commercial facilities.

Key Words: Pigs, Phosphorus, Commercial Facilities

136 Available phosphorus requirement to maximize growth and bone mineralization in 9 to 22-kg pigs.

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A total of 128 barrows (9.5 kg BW) were used in a 21-d feeding experiment to determine the available phosphorus (aP) requirement that maximizes growth performance and bone mineralization. Pigs were allotted by weight to one of eight dietary treatments in a completely randomized design with two pigs/pen and eight replications/treatment. Dietary treatments were formulated to contain varying levels of aP through the addition of monosodium phosphate (MSP). Concentrations of aP ranged from 0.08% to 0.64% at 0.08% increments. All diets were corn-soybean meal-based and formulated to contain 1.25% true digestible lysine and a fixed 1.2:1 Ca:total P ratio. The basal diet contained no added MSP. Breaking load and ash content of the left fibula were determined on all pigs at the end of the 21-d test period. Pen served as the experimental unit. Average daily gain, ADFI, and gain:feed increased quadratically ($P < 0.01$) as aP concentration increased in the diet. Two-slope regression analysis indicated that the breakpoint for ADG (0.55 kg/d) and gain:feed (0.74) occurred at 0.22% and 0.29% dietary aP, respectively. Bone breaking load, grams of fibula ash, and percentage of fibula ash also increased quadratically ($P < 0.01$) as dietary aP concentration increased. Fibula ash, as a percentage of dried fat-free bone weight, was maximized in pigs fed the 0.56% aP diet. However, breakpoint analysis determined the point of inflection to be 0.36% dietary aP. Break-point analysis was not appropriate for evaluation of bone breaking load or grams of fibula ash content. Therefore, 90% of quadratic maximum response of these criteria was utilized to estimate the requirement. Both bone breaking load and grams of fibula ash were maximized at 0.56% aP, but 90% of quadratic maximum occurred at 0.41% and 0.39% dietary aP, respectively. These results indicate a differential aP requirement (growth performance, 0.29%; bone mineralization, 0.41%) for the 9 to 22-kg pig depending upon the evaluation criteria measured.

Key Words: Phosphorus, Pigs, Bone

137 Phosphorus balance in growing pigs fed semi-purified diets adequate or low in dietary phosphorus.

L. A. Pettey*, G. L. Cromwell, and M. D. Lindemann, *University of Kentucky, Lexington*.

An experiment was conducted to measure P balance of growing pigs fed semi-purified diets at or below the dietary requirement for P and to estimate the portion of excreted P attributable to endogenous origin. Twelve pigs (59.4 kg) were penned individually in metabolism crates and randomly assigned to three dietary treatments. Diets were: (1) a semi-purified sucrose-dextrose-cornstarch-casein diet (0.82% lysine, 0.08% P) with no added P; (2) as 1 with 0.07% added P from monosodium phosphate (MSP); and (3) as 1 with 0.14% added P from MSP. Calcium was added as Ca carbonate to each diet so that total Ca and P in Diets 1, 2, and 3 were 0.21 and 0.08; 0.39 and 0.15; and 0.57 and 0.22%, respectively. Cellulose (4%) and sand (1%) also were added to the diet. Pigs were fed twice daily equal amounts of feed per replicate to maintain incremental P intake. Pigs were adjusted to treatments for 7 d, followed by a 6-d marker-to-marker collection period. ADG was similar ($P > 0.10$) for each dietary treatment. DM and P intakes for Diet 1, 2, and 3 were 2220, 2237, and 2243 g/d; and 2.18, 3.69, and 5.32 g/d, respectively. Phosphorus excretion in the feces increased linearly ($P < 0.01$) with increasing P intake. Urinary P excretion was low for Diets 1 and 2 (0.018 and 0.102 g/d; $P > 0.10$) but increased ($P < 0.01$) for Diet 3 (0.901 g/d). Absorption and retention of P as a percentage of intake for Diets 1, 2, and 3 were 86.5, 89.8, and 91.1%, and 85.7, 87.1, and 73.9%, respectively. When P absorption (g/d) was regressed on P intake, the relationship was linear ($R^2 = 0.99$) with $y = 0.945x - 0.1556$. Similarly, as P intake increased, fecal P excretion (g/d) also increased linearly ($R^2 = 0.68$) with $y = 0.0608x + 0.1556$. From the two intercepts, excretion of endogenous P in the feces was estimated to be 156 mg/d. Based on

this experiment, we estimate the daily endogenous contribution of fecal P loss to be approximately 2.6 mg/kg BW in 60-kg growing pigs fed semi-purified diets at or below the dietary requirement for P.

Key Words: Endogenous Loss, Phosphorus Balance, Pigs

138 Whole body composition and phosphorus accretion in growing pigs. L. A. Pettey*, G. L. Cromwell, and M. D. Lindemann, *University of Kentucky, Lexington.*

An experiment was conducted to determine whole body accretion of P in growing pigs. Five sets of five littermate barrows (18 kg) were allotted randomly to five slaughter groups (18, 27, 36, 45, and 54 kg BW). Average initial BW was equalized among slaughter groups. Pigs were fed fortified corn-SBM diets that met or exceeded requirements for all nutrients in two dietary phases (Phase 1, 18-36 kg, 1.10% lysine; Phase 2, 36-54 kg, 0.91% lysine). At assigned BW, pigs were killed and body components were separated into hair, toenails, blood, head, empty viscera, and carcass. Carcasses were split along the dorsal midline with the left side ground for analysis and the right side dissected into lean tissue, fat tissue, skin, and bone. The empty viscera and head components also were ground for analysis. Mass and accretion rates of DM, N, lipid, ash, and P were determined for each body component and dissected tissue. Whole body composition of pigs in each group were: empty body weight (EBW): 16.4, 26.1, 34.1, 43.1, 51.6 kg; N: 397, 650, 888, 1090, 1314 g; ash: 408, 642, 844, 1037, 1268 g; P: 71, 111, 146, 191, 236 g. Accretion rates from 18 kg to final BW for each group were: EBW: 583, 669, 716, 787 g/d; N: 15.0, 18.4, 18.4, 20.5 g/d; ash: 13.9, 16.4, 16.7, 19.2 g/d; P: 2.6, 3.0, 3.3, 3.8 g/d. As EBW increased, the mass (g) of N, ash, and P increased linearly ($R^2 = 0.98$). N:P did not change with increasing EBW ($R^2 = 0.01$) and averaged 5.8 across all weight groups. P accretion rate was linearly ($P < 0.10$) related to N accretion rate ($R^2 = 0.82$) and ash accretion rate ($R^2 = 0.68$). Expressed as a percentage of EBW, whole body composition of pigs in each group were: N: 2.41, 2.49, 2.61, 2.53, 2.55%; ash: 2.46, 2.46, 2.47, 2.41, 2.46%; P: 0.43, 0.42, 0.43, 0.44, 0.46%. Dissected muscle, fat, bone, and skin tissues were: 62.9, 14.9, 15.9, and 6.3% of the carcass for 18 kg pigs, compared with 64.2, 19.0, 12.2, and 4.6% for 54 kg pigs. Based on this study, P retention appears to increase linearly with EBW and is positively related to the accretion of N and ash in 18 to 54 kg growing pigs.

Key Words: Body Composition, Phosphorus, Pigs

139 Effects of an experimental phytase product on phosphorus utilization in pigs. A. M. Gaines*[1], D. C. Kendall[1], J. W. Frank[1], G. F. Yi[1], R. W. Fent[1], G. L. Allee[1], J. D. Spencer[2], and D. M. Webel[2], [1]*University of Missouri, Columbia,* [2]*United Feeds, Inc., Sheridan, IN.*

A 28 d trial was conducted to evaluate the efficacy of an E-coli phytase product (EcoPhos™; Phytex; Portland, ME) on improving the utilization of phytate-bound P in growing pigs. At an initial weight of approximately 8.3 kg, a total of 108 nursery pigs (TR-4 × PIC C22) were allotted to one of nine dietary treatments in a randomized complete block design with six replicate pens per treatment (Trt). The basal diet (Trt 1) was a corn-soybean meal-based diet formulated to contain 0.08% available P, 0.80% Ca, and 1.30% total lysine. Trts 2-4 consisted of the basal diet with three levels of added P (0.05, 0.10, and 0.15%) from monosodium phosphate (MSP) to generate a standard curve for calculation of phytase induced P release. Trts 5-8 consisted of the basal diet supplemented with four levels of EcoPhos™ that supplied 250, 500, 1000, and 2000 phytase units (FTU/kg) of complete feed, respectively. Trt 9 consisted of the basal diet supplemented with Natuphos® phytase that supplied 500 FTU/kg of complete feed. Feed intake, weight gain, and feed efficiency were calculated at the end of the 28 d period, at which time fibulae were removed for ash determination. Both ADG and G:F responded linearly ($P \leq 0.001$) to graded increments of P from MSP (Trts 1-4). Similarly, there was a linear improvement ($P \leq 0.001$) in ADG, G:F and ADFI with the addition of graded levels of supplemental phytase from EcoPhos™. No differences ($P \geq 0.76$) were observed between EcoPhos™ and Natuphos® when supplemented at 500 FTU/kg of complete feed for any of the growth parameters measured. Based on the linear regression of fibula ash on supplemental P intake ($r^2 = 0.75$) the addition of supplemental phytase from EcoPhos™ resulted in a linear improvement in bioavailable P release ($P \leq 0.001$). There were no observed differences ($P \geq 0.67$) in bioavailable P release between EcoPhos™ and Natuphos® (0.08 vs. 0.07%, respectively). These results indicate that supplemental phytase from EcoPhos™ linearly improves utilization of phytate P in corn-soybean meal-based diets fed to young pigs.

Key Words: Phytase, Pigs

140 Effects of a solid-state fermented phytase on growth performance and phosphorus excretion of growing pigs fed corn-soybean meal diets. J. S. Park*, S. D. Carter, J. D. Schneider, and T. B. Morillo, *Oklahoma State University, Stillwater.*

Forty-two barrows (avg BW = 19.9 kg) were used in a 33-d study to determine the effects of the addition of a solid-state fermented phytase complex (Allzyme SSF; Alltech, Inc) to low P, corn-soybean meal diets on growth performance and P excretion. Pigs were blocked by weight and ancestry, and randomly allotted to one of seven dietary treatments (6 pigs/trt). A basal diet consisted of corn and soybean meal and was adequate in all nutrients, except Ca and P. This diet contained 0.34% total P (0.07% available P), all of which was provided by corn and soybean. Treatments were the basal, the basal plus monosodium phosphate (MSP) to provide 0.05, 0.10, and 0.15% added available P, and the basal plus enzyme to provide 250, 500, and 1,000 PU/kg. All diets were formulated to 0.95% total lysine and a Ca:total P ratio of 1.2:1. Pigs were housed individually in metabolic chambers with ad libitum access to feed and water. There were two 5-d total collection periods (d 10-15 and d 25-30) during the 33-d study. Overall, ADG and G:F were, respectively: 0.63, 0.67, 0.74, 0.72, 0.69, 0.74, 0.74 kg/d and 0.45, 0.47, 0.48, 0.49, 0.47, 0.48, 0.49 kg/kg. ADG and G:F increased (linear, $P < 0.03$) with addition of MSP or SSF. However, ADFI was not affected by either addition of MSP or SSF. The addition of 500 or 1,000 PU/kg to the low P, corn-soybean meal diet increased ADG and G:F similar to that for the highest level of MSP. Dry matter, N, and energy digestibility were not different ($P > 0.10$) among treatments, but digestibility of P (44.1, 49.7, 55.8, 60.7, 54.8, 59.5, and 70.5%, respectively) increased (linear, $P < 0.01$) with addition of MSP or SSF. Compared to the basal diet, additions of SSF decreased P excretion (3.06 vs 2.99, 2.35, 1.67 g/d) by 19.3, 23.3, and 45.4%, respectively. These data indicate that the addition of a solid-state fermented phytase improves growth performance and P utilization, and markedly reduces P excretion of pigs fed low-P, corn-soybean meal diets.

Key Words: Pigs, Phytase, Excretion

141 Effects of a solid-state fermented phytase on bone traits and tissue accretion rates of growing pigs fed corn-soybean meal diets. J. S. Park*, S. D. Carter, J. D. Schneider, and T. B. Morillo, *Oklahoma State University, Stillwater.*

A 33-d experiment using 42 barrows (avg BW = 19.9 kg) was conducted to determine the effects of solid-state fermented phytase complex (Allzyme SSF; Alltech, Inc) addition to low P, corn-soybean meal diets on bone traits and tissue accretion rates. Pigs were blocked by weight and ancestry, and randomly allotted to one of seven dietary treatments (6 pigs/trt). A basal diet consisted of corn and soybean meal and was adequate in all nutrients, except Ca and P. This diet contained 0.34% total P (0.07% available P), all of which was provided by corn and soybean meal. Treatments were the basal, the basal plus monosodium phosphate (MSP) to provide 0.05, 0.10, and 0.15% added available P, and the basal plus enzyme to provide 250, 500, and 1,000 PU/kg. All diets were formulated to 0.95% total lysine and a Ca:total P ratio of 1.2:1. Pigs were individually housed in metabolic chambers and allowed ad libitum access to feed and water. At the end of the 33-d study, all pigs were killed, the femurs were excised, and the feet removed to collect the 3rd/4th metacarpals and metatarsals (MM). The remainder of the carcass was ground for ash and P analysis. Bone breaking strength (BS) of MM and femurs and ash (%) increased (linear, $P < 0.01$) with increasing MSP or SSF (35.5, 46.2, 55.2, 69.7, 48.5, 59.3, 65.5 kg; 113, 141, 197, 236, 164, 213, 220 kg; and 47.4, 48.9, 50.3, 52.5, 49.6, 51.5, 52.2%, respectively). Based on average BS and ash, addition of 250, 500, or 1,000 PU/kg was equivalent to 0.066, 0.120, and 0.140% available P, respectively. For the carcass, the contents (%) and accretion rates of water, protein, and fat were not affected ($P > 0.10$) by either MSP or SSF. The content (%) and accretion of P and ash increased (linear, $P < 0.01$) with addition

of MSP and SSF. The increase in bone strength and carcass P associated with increasing SSF was similar to that for MSP addition. These data indicate a solid-state fermented phytase improves P utilization in growing pigs fed low P, corn soybean meal diets.

Key Words: Pigs, Phytase, Bone Strength

142 Efficacy of an *E. coli* phytase for growing-finishing pigs and laying hens. N. R. Augspurger*[1], D. M. Webel[2], and D. H. Baker[1], [1]*University of Illinois, Urbana,* [2]*United Feeds, Inc., Sheridan, IN.*

Two trials were conducted to determine the efficacy and safety of an *E. coli* phytase expressed in yeast (ECP; EcoPhos^{TM}, Phytex, Portland, ME) when added to P-deficient corn-soybean meal diets fed to growing-finishing (GF) pigs and second-cycle laying hens. Sixty GF pigs (49 kg BW) were randomly allotted to either the P-deficient diet, or the P-deficient diet supplemented with either 0.10% inorganic P (iP) from KH_2PO_4 or 250, 500, 1,000, or 10,000 FTU/kg of ECP. Pigs were individually fed and allowed ad libitum access to the experimental diets until individual blocks of pigs reached 120 ± 4 kg BW, at which time pigs were euthanized and the left fibula and 4^{th} metatarsal were harvested for determination of bone ash. Pigs were fed a two-phase dietary program for early- and late-finishing pigs; available P in the basal diets was set 0.10% below the requirement. The sexes responded differently (sex × iP vs phytase, $P < 0.05$) in weight gain to addition of ECP, wherein ECP additions were superior to iP additions in gilts but equal to iP additions in barrows. Fibula ash was highest ($P < 0.01$) for pigs fed diets containing 10,000 FTU/kg of ECP. Supplementation of 0.10% iP resulted in bone ash responses that were equal to those resulting from 500 FTU/kg of ECP. Laying hens (n = 240) were allotted to a P-deficient diet, or the P-deficient diet supplemented with either 0.10% iP (from KH_2PO_4) or 150, 300, or 10,000 FTU/kg of ECP for a 12-wk assay. The basal diet was a corn-soybean meal diet with no added iP (17% CP, 3.8% Ca, 0.07% estimated available P). Hens on the P-deficient diet were removed from the study after 4 wk due to poor egg production. Supplementation of iP and ECP resulted in superior ($P < 0.01$) feed intake, egg weight, and egg production during the first 4 wk. There were no differences ($P > 0.05$) among the iP- and ECP-supplemented groups in body weight, feed intake, egg weight, or egg production at the end of the 12-wk trial. These studies revealed that ECP was as efficacious as 0.10% supplemental iP, and that supplementation of a 10 to 20-fold higher dose of ECP was safe in both GF pigs and laying hens.

Key Words: Phytase, Pigs, Hens

143 Phytase from transgenic alfalfa leaf meal improves phosphorus bioavailability in growing pigs. K. L. Saddoris*, D. K. Schneider, and T. D. Crenshaw, *University of Wisconsin, Madison.*

Twenty crossbred barrows (∼9 kg BW) were randomly assigned to dietary treatments to evaluate growth, apparent digestibility of P and Ca, and bone mineral content (BMC) gain responses to phytase supplementation in corn-SBM diets. Phytase was provided by leaf meal from alfalfa plants genetically modified to express phytase protein (t-alfalfa). Dietary treatments consisted of corn-SBM diets with 0.45, 0.50, or 0.55% total phosphorus (tP) without phytase plus diets (0.45% tP) with either 200 or 400 FTU/kg obtained by t-alfalfa additions at 1.33 or 2.66 g/kg diet, respectively. Pigs (10/trial) were individually penned for 16 d (trial 1) and 13 d (trial 2) for diet adaptation, then placed in crates for a 4 d total collection of urine and feces. Initially, pigs were scanned with dual-energy x-ray absorptiometry to determine BMC and re-scanned on d 1 and d 4 of collection. Over the trial, supplemental P tended to increase ADG (quadratic, $P < 0.1$), fecal P excretion (quadratic, $P < 0.1$), and BMC gain (linear, $P < 0.05$). Increasing tP levels increased Ca retention (quadratic, $P < 0.01$) and BMC gain (linear, $P < 0.05$). ADFI, feed:gain, P and Ca apparent digestibility did not differ ($P > 0.1$) among tP treatments. Compared to the 0.45% tP group, pigs fed diets with 200 FTU/kg increased ($P < 0.05$) P retention (2.48 to 3.65 g/d) and increased ($P < 0.05$) Ca retention (3.48 to 5.39 g/d). However, increasing from 200 to 400 FTU/kg decreased ($P < 0.05$) P retention (3.65 to 2.61 g/d) and Ca ($P < 0.01$) retention (5.39 to 4.01 g/d). During the collection period phytase supplementation increased ($P < 0.01$) BMC gain (10.34 and 9.37 g/d for 200 and 400 FTU/kg groups, respectively) compared with pigs fed 0.45, 0.50, and 0.55% tP (3.56, 7.12, and 7.50 g/d). ADG, ADFI, feed:gain, fecal P excretion, apparent digestibility of P and Ca, and BMC gain did not differ ($P > 0.1$) between the 200 and 400 FTU/kg treatments. In conclusion, t-alfalfa phytase improves P bioavailability from corn-SBM diets as indicated by a 65% increase in BMC gain over the collection period compared to pigs fed diets with 0.45% tP. Supplementing t-alfalfa at a level greater than 200 FTU/kg offered no advantage, indicating a greater bioavailability of t-alfalfa phytase than predicted by phytase activity assays.

Key Words: Pigs, Phytase, Phosphorus

144 Effect of phytase on growth performance, plasma metabolites, carcass traits, and pork quality in growing-finishing pigs. J. L. Shelton*, L. L. Southern, and T. D. Bidner, *Louisiana State University Agricultural Center, Baton Rouge.*

An experiment was conducted to determine the effect of phytase (Natuphos®) on growth performance, plasma metabolites, carcass traits, and pork quality in growing-finishing pigs. Pigs (initial and final BW of 22 and 108 kg) were allotted to three treatments with six replications (three barrow and three gilt) of four pigs each in a randomized complete block design. The three dietary treatments were: 1) corn-soybean meal (C-SBM) control, 2) C-SBM with Ca and aP reduced by 0.10%, 3) as Diet 2 + 500 FTU phytase/kg. Blood was collected from pigs on d-29 and at slaughter. Three pigs per replicate were randomly selected for slaughter. Pigs fed the reduced Ca and aP diet had a decreased ($P < 0.05$) ADG relative to those fed the control diet or diet with phytase. Daily feed intake was decreased ($P < 0.10$) in pigs fed the reduced Ca and aP diet relative to pigs fed the control diet. Gain:feed, plasma NEFA, and fasting plasma glucose were not affected ($P > 0.10$) by diet. Pigs fed the reduced Ca and aP diet had increased ($P < 0.05$) liver and kidney weights and decreased ($P < 0.05$) dressing percentage, hematocrit, and bone ash percentage relative to pigs fed the control diet or the diet with phytase. Tenth-rib backfat thickness was increased ($P < 0.10$) in pigs fed the reduced Ca and aP diet relative to pigs fed the diet with phytase. Kilograms of lean were decreased ($P < 0.10$) in pigs fed the reduced Ca and aP diet relative to pigs fed the control diet. The CIE L* value was decreased ($P < 0.10$) in pigs fed the diet with phytase compared to pigs fed the control or reduced Ca and aP diets. These data indicate that reducing the Ca and aP in diets for growing-finishing pigs results in decreased growth performance and inferior carcass traits, all of which were returned to normal by dietary phytase. Furthermore, phytase supplementation to reduced Ca and aP diets had no negative effects on growth, carcass traits, or pork quality in growing-finishing pigs.

Key Words: Phytase, Pigs, Pork Quality

145 Evaluation of phytase source and level in diets for pigs 12 to 86 kg body weight. B. V. Lawrence[1], J. D. Hahn[1], J. Boychuk*[2], S. Hansen[1], J. Hedges[1], E. Hansen[1], R. Musser[1], and G. Dial[3], [1]*Hubbard Feeds Inc., Mankato, MN,* [2]*Feed-Rite, Winnipeg, MB Canada,* [3]*New Fashion Pork, Jackson, MN.*

Two experiments were conducted to evaluate phytase source (Natuphos® vs. Ronozyme® P) in corn-soy bean meal diets. In Exp. 1, 985 pigs (C22 X TR4) weighing 12.2 ± 0.75 kg were allotted to 6 treatments (n = 6). Treatments included Negative (Neg) Control (0.50% P), Positive (Pos) Control (0.70% P), or Neg with 300 or 500 FTU/kg of phytase from Natuphos or Ronozyme P. Pigs were housed in a conventional nursery at 27 or 28 pigs/pen. During the 21-d trial, pigs fed either source of phytase and the Pos diet had gains greater than (561 vs. 528 g/d) the Neg group ($P < 0.05$) Gains for the Phytase and Pos groups were similar ($P > 0.10$). Gain was similar across levels of phytase ($P > 0.10$). Intake was greater ($P < 0.05$) for pig fed phytase (881 vs. 837 g/d) compared with the Neg and Pos fed pigs. No phytase source or level differences were detected ($P > 0.10$). Gain/feed was greater ($P < 0.001$) for the Pos pigs than for other treatments (0.68 vs. 0.63). Gain/feed for the phytase pigs was similar ($P > 0.10$) to the Neg pigs regardless of source or level. Experiment 2 evaluated the interaction of Natuphos and Ronozyme P. A total of 1,004 Compart Boar Store terminal Duroc pigs (L442 X D100) weighing 14.7 ± 0.81 kg were allotted to 4 dietary treatments (n = 12). All diets were formulated to 500 FTU/kg phytase from Natuphos and/or Ronozyme P in ratios of 500/0, 375/125, 250/250, 125/375 FTU/kg. Diets were formulated to contain 0.60, 0.55, 0.50, and 0.45% total P during four 21-d growth periods ending at 29.7, 47.5, 68.1, and 86.2 kg, respectively. Pigs were housed in a curtain-sided, pit-ventillated finishing facility at 20 or 21 pigs per pen. No

treatment differences were detected (P > 0.10). Cumulative gain, intake, and gain/feed were 831 ± 41.8 g/d, 1.74 ± 0.08 kg/d, and 0.48 ± 0.02 respectively. These results suggest both sources of phytase are equally effective phosphorus deficient swine diets. Additionally, there do not appear to be any synergies between the two sources of phytase in phosphorus adequate diets.

Key Words: Phytase, Phosphorus, Pigs

146 Efficacy of phytase in diets containing high- and low-phytate corn and high- and low-phytate soybean meal.

E. G. Xavier*, G. L. Cromwell, and M. D. Lindemann, *University of Kentucky, Lexington*.

An experiment was conducted to assess the efficacy of phytase additions on the bioavailability of P in diets containing combination of normal corn (N-corn) and normal soybean meal (N-SBM), and low-phytate corn (LP-corn) and low-phytate soybean meal (LP-SBM) for growing pigs. Diet 1, a low P (0.11%), phytate-free basal diet (1.2% lysine, 0.8% Ca), consisted of casein, dextrose-sucrose (1:1), cellulose, supplemental AA, minerals (except P), and vitamins. In Diet 2, monosodium phosphate (MSP) provided 0.20% added P. Diet 3 was a 3:1 blend of N-corn and N-SBM substituted for the sugars to provide 0.26% added P. Diet 4 was as Diet 3 with phytase (Natuphos, 750 units/kg). Diet 5 was a 3:1 blend of LP-corn and LP-SBM providing 0.26% added P. Diet 6 was as Diet 5 with the addition of phytase. Non-phytate P levels of Diets 1 to 6 were: 0.11, 0.31, 0.17, 0.24, 0.29, and 0.32%, respectively. Each diet was fed to six individually penned pigs for 28 d, from 11.0 to 29.0 kg. Gain, feed intake, feed:gain, femur strength, metacarpal and metatarsal (MM) strength, and MM ash of pigs fed Diets 1-6 were: 426, 644, 602, 656, 699, 740 g/d; 947, 1186, 979, 999, 1049, 1094 g/d; 2.22, 1.84, 1.63, 1.53, 1.50, 1.48; 45, 184, 90, 136, 168, 193 kg; 16.2, 38.3, 25.9, 32.8, 37.7, 40.3 kg; and 2.20, 4.12, 3.04, 3.71, 3.89, 4.23 g (P < 0.01), respectively. Breaking strength of femurs and MM, and MM ash were regressed on added P intake and single-point, slope-ratio procedures were used to assess P bioavailability in the corn-SBM mixes, assuming MSP = 100. Bioavailability of P increased from 35% in the N-corn, N-SBM diet to 64% when phytase was added and from 79% in the LP-corn, LP-SBM diet to 90% when phytase was added. Apparent digestibility of P and P excretion of pigs fed Diets 1-6 were: 82, 86, 44, 58, 65, 79%; 0.28, 0.51, 2.03, 1.55, 1.37, 0.87 g/d (P < 0.01). The results indicate that phytase is efficacious when added to diets containing either high- or low-phytate corn and SBM, but its efficacy is greater in high-phytate diets than in low-phytate diets.

Key Words: Pigs, Phosphorus, Phytate

147 Effects of low phytic acid corn, low phytic acid soybean meal, and phytase on nutrient digestibility and excretion in growing pigs.

B. E. Hill*, S. L. Hankins, S. A. Trapp, A. L. Sutton, and B. T. Richert, *Purdue University, West Lafayette, IN*.

Forty-eight grower pigs were used to evaluate the effects of feeding low phytic acid (LPA) corn, LPA soybean meal, normal (NRM) corn, NRM soybean meal, and the phytase enzyme on P digestibility and excretion. Pigs (initial BW = 45.3 kg) were blocked by BW and ancestry and randomly assigned to one of eight dietary treatments in a 2×2×2 factorial arrangement (6 pigs/trt). Pigs were fed twice daily (0700 and 1700 hr) at three times maintenance requirement for energy (NRC, 1998). Phytase was added to the diet at 510 PU/kg of feed, at the expense of cornstarch, and all diets were formulated to provide 0.38% total P, 0.50% Ca, and 1.0% Lys with no supplemental P. Pigs were adapted to metabolism crates and dietary treatments for 7 d followed by a 3-d total collection of urine and feces. Total fecal DM excreted, %DM of feces, and %DM digested was not different (P > 0.53) among treatments. Fecal phosphorus excretion was reduced 11% for pigs fed LPA corn vs NRM corn, 2.87 vs 3.22 g/d (P < 0.05), 17% for pigs fed LPA soybean meal vs NRM soybean meal, 2.74 vs 3.34 g/d (P < 0.001), 18% for pigs fed phytase vs non-phytase diets, 2.74 vs 3.35 g/d (P < 0.02) and 43% for pigs fed LPA corn, LPA soybean meal, and phytase vs NRM corn, NRM soybean meal without phytase, 2.13 vs 3.76 g/d (P < 0.0001). Phosphorus digestibility was increased 21% for pigs fed diets containing LPA corn vs NRM corn, 48.3 vs 39.9% (P < 0.10), 16% for pigs fed LPA soybean meal vs NRM soybean meal, 47.3 vs 40.9% (P < 0.05), and 22% for pigs fed phytase vs non-phytase diets, 48.5 vs 39.7% (P < 0.008) respectively. Corn type and soybean meal type had no significant effect on water-soluble phosphorus (WSP) excretion. However, pigs fed diets containing phytase had significantly less total WSP excreted than those without phytase inclusion, 1.96 vs 2.29 g/d (P < 0.024). This study demonstrates that the feeding of any combination of LPA corn, soybean meal, and phytase can significantly improve P digestibility while dramatically decreasing P excretion.

Key Words: Phosphorus Digestibility, Pigs, Low Phytic Acid Grain

148 L-lysine disposal over 24 h exceeds the rate limiting step for piglet L-lysine catabolism.

N. J. Benevenga*, L. G. Haas, and T. D. Crenshaw, *University of Wisconsin, Madison*.

The first enzyme for saccharopine dependent catabolism of L-lysine (lysine α-ketoglutarate reductase, LKR), is exclusively housed in the matrix of liver mitochondria of piglets [J. Anim. Sci. 80(Suppl. 1): 30], thus mitochondrial uptake could be a rate limiting step. To identify dietary factors altering the capacity to degrade L-lysine, piglets were fed liquid diets containing 10, 50 or 75% protein for up to 12 d. When compared to 10% protein, 50 or 75% protein causes a 5-fold increase in piglet lysine oxidation (LOX) , a measure of mitochondrial lysine uptake, and a 10-fold increase in LKR (moles/(h·kg pig). To test the effect of lysine, piglets were fed liquid diets with 2, 4 or 6% of L-lysine added to a 10% protein diet. No decrease in piglet weight gain over 12 d and no increase in piglet LOX or LKR (mmoles/(d·pig) was observed. Comparison of the amount of L-lysine consumed over 24 h with the potential capacity of liver for L-lysine oxidation over 24 h revealed that less than 2% of the lysine consumed could be oxidized. Excess lysine must be degraded when 2, 4, or 6% is added to a 10% protein diet as amino acids can not be stored as such. In a preliminary study to determine the fate of lysine added to the low protein diet, two pairs of pigs were fed intragastrically (20 mL/h) via a Foley catheter, over 24 h, a diet containing 10% protein or 10% protein + 4% of L-lysine. Blood and urine samples were obtained at 6 h intervals. Piglets were killed, frozen and later homogenized. Free lysine was determined in the piglet homogenate. Lysine was analyzed by HPLC. Comparison of blood lysine over 24 h revealed a plateau in lysine concentration after 12 h in the piglets infused with the diet containing 4% free L-lysine. Comparison of the lysine recovered after subtracting the lysine recovered in the two piglets given the 10% protein from the two given the 10% protein diet + 4% free L-lysine revealed less than 1/3 of the increment of lysine infused could be recovered. The accepted pathway for lysine catabolism cannot account for the disappearance of lysine.

Key Words: Pigs, Lysine, Liver Mitochondria

149 Effects of dietary glutamine on growth performance and small intestine characteristics of weanling pigs before and after an immune challenge.

S. J. Kitt*, P. S. Miller, and R. L. Fischer, *University of Nebraska, Lincoln*.

A total of 36, 20-d-old pigs with an initial BW of 6.52 kg (± 0.38) were individually housed and used in a 14-d growth study. Pigs were blocked by location (n = 6) and randomly assigned to one of three dietary treatments during d 0 to 7 and one of six treatments during d 7 to 14. Treatments during d 0 to 7 were: a purified control diet (Lysine = 1.55%; ME = 2,800 kcal/kg) (CON), CON + 5 % glutamine (GLN), and CON + mixture of nonessential amino acids (NAA). Treatments during d 7 to 14 were CON, GLN, and NAA diets and an injection of saline (SAL) or 200 mg kg BW^{-1} lipopolysaccharide (LPS) from E. coli. Average daily gain and ADFI were measured on d 7 and 14. Pigs were euthanized on d 14 and small intestine length and wet weight were measured. Diet did not affect ADG (P ≥ 0.21), ADFI (P ≥ 0.79), or ADG/ADFI (P ≥ 0.26) during d 0 to 7. During d 7 to 14, LPS reduced ADG (109 vs 209 g; P ≤ 0.001) and ADG/ADFI (0.74 vs 0.50 g/g; P ≤ 0.001) by 48% and 32%, respectively. Pigs fed GLN and injected with LPS had a smaller reduction in ADG and ADG/ADFI than other dietary treatments, which resulted in a diet × injection interaction (P ≤ 0.02; P ≤ 0.05, respectively). Feed intake was reduced (P ≤ 0.005) by 25% in pigs injected with LPS. Pigs fed GLN and injected with LPS had similar ADFI compared to pigs fed GLN and injected with SAL (diet × injection interaction, P ≤ 0.06). From d 0 to 14, diet did not affect (P ≥ 0.22) ADG, ADFI, or ADG/ADFI. Injection of LPS reduced ADG (P ≤ 0.05) and there was diet × injection interaction (P ≤ 0.05) for ADFI. Small intestine length and empty weight were reduced (10.49 vs 9.19 m, P ≤ 0.001; 305 vs 259 g, P ≤ 0.001, respectively) for pigs injected with LPS. Pigs fed GLN and injected with LPS tended to have similar

empty small intestine weight compared to pigs fed GLN and injected with SAL (diet × injection, P ≤ 0.07). These data suggest that dietary glutamine improves growth performance and small intestine characteristics in weanling pigs after an immune challenge.

Key Words: Glutamine, Pigs, Immune Challenge

150 Impact of glutamine and spray-dried plasma on growth performance, small intestinal morphology, and immune responses in *Escherichia coli* K88$^+$ challenged weaned pigs. G. F. Yi*[1], J. A. Carroll[2], G. L. Allee[1], A. M. Gaines[1], D. C. Kendall[1], Y. Toride[3], and I. Izuru[3], [1]*University of Missouri, Columbia,* [2]*ARS-USDA, Columbia, MO,* [3]*Ajinomoto Co. Inc., Japan.*

A total of 40 barrows (5.32 ± 0.3 kg) were used to investigate the effects of feeding glutamine (GLN) and spray-dried plasma (SDP) diets on *E. coli* K88$^+$ LT/STb$^+$ challenged pigs. Pigs were allotted in a RCBD to four dietary treatments which included: positive control (POS), negative control (NEG), SDP and GLN treatments. The POS and NEG were fed the same corn-soy-whey diet, whereas the SDP and GLN were fed 7% SDP and 2% GLN supplemented diets, respectively. On d 11 postweaning, all pigs were fitted with indwelling jugular catheters. On d 12 postweaning, pigs on the NEG, SDP and GLN were orally challenged with 5.5 X 10^8 CFU *E. coli* K88$^+$, whereas pigs on the POS were treated with skim milk. Rectal temperature and fecal diarrheic scores were recorded and blood samples collected, at 0, 6, 12, 24, 36, and 48 h postweaning for serum hormone and cytokine measurements. At 48 h post-challenge, all pigs were sacrificed for small intestinal morphology evaluation. At 48 h post-challenge, compared to the non-challenged POS, pigs on the NEG had decreased ADG and G: F (P ≤ 0.08). However, feeding both SDP and GLN alleviated growth depression and feed efficiency reduction associated with *E. coli* challenge. At 12 h post-challenge, pigs on the NEG had the highest incidence of diarrhea among treatments (P ≤ 0.09). There were no treatment X time interactions for rectal temperature (P ≥ 0.81), ACTH (P ≥ 0.74), cortisol (P ≥ 0.43), or IL-6 (P ≥ 0.10) during the *E. coli* challenge period. In proximal, mid-jejunum and ileum, compared with the POS, pigs on the NEG had greater villous atrophy and intestinal morphology disruption (P ≤ 0.08), whereas feeding both SDP and GLN mitigated or prevented villous atrophy and intestinal morphology impairment after *E. coli* challenge. At 6 h post-challenge, compared to baseline measurement, all pigs had increased GH (P ≤ 0.001) and decreased IGF-1 (P ≤ 0.001). At 12 h post-challenge, pigs on the POS had higher IGF-1 compared to the *E. coli* challenged pigs (P ≤ 0.08). These results indicate that feeding SDP and GLN have beneficial effects in alleviating growth depression of *E. coli* K88$^+$ challenged pigs mainly via maintaining intestinal morphology and function, and possibly via modulating the somatotrophic axis.

Key Words: Pigs, Glutamine, Spray-dried Plasma

151 Effect of a β-glucan product on performance and immune function of weanling pigs. S. Singh[1], J. D. Arthington[2], D. C. Brown[1], M. E. Davis*[1], Z. B. Johnson[1], P. A. Willis[3], and C. V. Maxwell[1], [1]*Univeristy of Arkansas, Fayetteville,* [2]*University of Florida, Gainesville,* [3]*Cypress Systems, Inc., Fresno, CA.*

An experiment using 120 pigs was conducted to monitor the impact of feeding different levels of a β-glucan product, BetaPrecise 929 (Cypress Systems, Inc. Fresno, CA), on performance and inflammation of weaned pigs. Pigs (19 ± 3 d of age) were sorted into eight weight blocks and allotted into six equal subgroups (2-3 pigs/pen) with stratification based on sex and litter. Treatments were randomly assigned to pens within each block (16 pens/treatment). Pigs were fed one of three dietary treatments from d 0 to 10 after weaning: 1) Control diet (1.6% Lys), 2) Control diet supplemented with 0.05% BetaPrecise 929, 3) Control diet supplemented with 0.10% BetaPrecise 929. Treatments were fed throughout phase 2 (1.40% Lys, d 10 to 20) and phase 3 (1.23% Lys, d 20 to 31). Serum from three pigs per treatment per block was collected on d 0, 3, 7, 14, and 28 to measure acute phase protein (ceruloplasmin and haptoglobin) levels. During the overall study, ADG was higher (P ≤ 0.10) for pigs fed BetaPrecise 929 compared to pigs fed the control diet (0.37 ± 0.01 and 0.34 ± 0.01 kg). During the combined phase 1 and 2 periods, pigs fed BetaPrecise 929 had higher (P ≤ 0.05) G:F (0.76 ± 0.02 and 0.78 ± 0.02 for 0.05% and 0.10% supplementation, respectively) compared to pigs fed the control diet (0.72 ± 0.02). At the termination of the study, pigs fed 0.05% and 0.10% BetaPrecise 929 supplemented diets were, respectively, 0.98 and 0.99 kg heavier (P ≤0.14) than pigs fed the control diet. On d 14 after weaning, pigs fed the control diet had higher (P ≤ 0.01) levels of ceruloplasmin when compared to pigs fed BetaPrecise 929 supplemented diets. On d 28 after weaning, pigs fed the control diet had lower (P ≤ 0.04) haptoglobin levels as compared to pigs fed BetaPrecise 929 supplemented diets. The study indicates that β-glucan can be fed to nursery pigs to improve weight gain and impact the acute phase response.

Key Words: Beta-glucan, Acute Phase Proteins, Nursery Pigs

152 Effect of dose of sodium chlorate on growth performance of nursery pigs. T. E. Burkey*, S. S. Dritz, and J. E. Minton, *Kansas State University, Manhattan.*

A feed additive that shows promise for pigs as an alternative to commonly fed antimicrobials is sodium chlorate (CHLOR). Pigs orally gavaged with CHLOR had decreased bacterial numbers following infection with *Salmonella typhimurium* (ST). However, the effect of chronic feeding of CHLOR to pigs on growth performance has not been thoroughly evaluated. Feeding 800 mg/kg CHLOR to weaned pigs challenged orally with ST appeared to decrease feed intake and growth. Thus, our objective was to determine if lower rates of dietary CHLOR inclusion would affect nursery pig growth performance. A total of 84 nursery pigs (13.1 ± .9 kg) were blocked by weight and assigned randomly within blocks to four dietary treatments. Experimental diets were fed in meal form for a total of 14 d. Dietary energy, mineral and vitamin levels were held constant across all treatments. The dietary treatments included a control (0 mg CHLOR/kg) and three levels of CHLOR (200, 400, and 800 mg/kg). Each pen contained 3 pigs, with 7 replicates (pens) per treatment. Pigs were weighed and feed disappearance was measured on d 0, 7, and 14 to determine ADG, ADFI and F/G. Overall (d 0 to 14), pigs fed diets containing 200 mg CHLOR/kg had greater (P < 0.01) ADG and ADFI than pigs fed diets containing 800 mg CHLOR/kg. Although, ADG from d 0 to 14 did not differ significantly for pigs fed the control diet and pigs fed 200 mg CHLOR/kg. Generally, ADG, ADFI, and F/G improved linearly as dietary CHLOR decreased from 800 to 200 mg/kg (P < 0.01, P < 0.02, and P < 0.08, respectively). At d 14, pigs fed 200 mg CHLOR/kg had increased (P < 0.01) body weight compared to pigs fed the diet containing 800 mg CHLOR/kg. Also, there was a strong linear trend for d 14 average weights to be increased as CHLOR content decreased from 800 to 200 mg/kg (P < 0.01). The addition of CHLOR at levels less than 800 mg/kg may be beneficial in improving ADG, ADFI, and F/G in nursery pigs. Further work is warranted to determine if levels of CHLOR less than 800 mg/kg are, in fact, antimicrobial when added to diets for nursery pigs.

Key Words: Sodium Chlorate, Antimicrobials, Nursery Pigs

153 Effect of dietary mannanoligosaccharide and sodium chlorate on bacterial shedding in weaned pigs challenged with *Salmonella enterica* serotype Typhimurium (ST). T. E. Burkey*, S. S. Dritz, J. C. Nietfeld, B. J. Johnson, and J. E. Minton, *Kansas State University, Manhattan.*

There continues to be a high level of interest in potential alternatives to dietary antibiotics for swine. The current study was conducted to evaluate the effect of two potential feed additives on bacterial shedding in weaned pigs undergoing enteric disease challenge. One substance of interest, mannanoligosaccharide (MOS), may alter health status of pigs. The second product, sodium chlorate (CHLOR), is effective in reducing bacterial numbers in pigs infected with ST. But, the effect of chronic dietary inclusion of these products on fecal shedding of bacteria following ST challenge has not been reported. Ninety six weaned pigs (6.3 ± 1.3 kg) were blocked by weight and assigned randomly within blocks to four dietary treatments. The negative control diet contained no added antimicrobial (CON), whereas the positive control contained Carbadox (CARB; 55 ppm). Test diets contained MOS (1.5 g/kg) or CHLOR (800 mg/kg). There were 12 pens per treatment with 2 pigs/pen. Pigs were fed treatment diets for 2 wk. Then, all pigs were given ST orally, and the study continued for an additional 2 wk. Fecal samples were obtained after 7 and 14 d post-challenge, and evaluated for the presence of Salmonella organisms using a semi-quantitative approach. Samples were scored on a 0 to 3 scale (0 = no culturable Salmonella; 3 = abundant culturable Salmonella). At 7 d, shedding scores were lower (P < 0.05) for pigs fed CHLOR (1.2 ± 0.2) than CON (2.1 ± 0.2), CARB (2.1 ± 0.2), and MOS (2.2 ± 0.2) treatments. At d 14, pigs fed CON, CARB, and MOS had similar shedding scores, although pigs fed CARB had

lower scores than pigs fed CHLOR ($P < 0.05$). Thus, in this model of enteric disease challenge in weaned pigs, the presence of dietary CHLOR altered the pattern of fecal shedding of Salmonella.

Key Words: Mannanoligosaccharide, Sodium Chlorate, Bacterial Shedding

154 Effects of Ractopamine HCl (Paylean) on Finishing Pig Growth and Variation. M. R. Barker*, S. S. Dritz, R. D. Goodband, M. D. Tokach, C. N. Groesbeck, S. M. Hanni, C. W. Hastad, T. P. Keegan, K. R. Lawrence, and M. G. Young, *Kansas State University, Manhattan*.

A total of 336 pigs were used in a 21-d study to determine the effect of Ractopamine HCl (Paylean, 10 mg/kg) on finishing pig growth and variation. Pigs (168 barrows and 168 gilts) were weighed and allotted to treatments in a completely random design so that within sex, each pen had the same mean BW and degree of BW variation among pigs in each pen. Fourteen pens (7 of barrows, 7 of gilts) were assigned to each treatment. Diets were a sorghum-soybean meal-based and formulated to contain 1.00% total Lys with or without 10 mg Paylean/kg. Pigs were weighed and feed intake was determined every 7 d during the 21 d experiment. Average daily gain, ADFI, feed efficiency (G/F), and pen CV were determined. Pigs fed Paylean had greater ADG and improved feed conversion compared to control pigs ($P < 0.05$; 0.939 kg/d and 0.327 vs 0.798 kg/d and 0.276, respectively). Feed intake was not affected ($P > 0.90$) by dietary treatment (2.76 vs 2.77 kg/d, respectively). Pigs fed Paylean were heavier ($P < 0.05$) at the end of the 21 d trial (120 vs 116 kg), due to higher ADG than the pigs fed the control diet. Initial pen CV was 9.2% and 8.7% for the pigs on control and Paylean diets, respectively. At the end of the 21 d study, no differences were observed in pen BW variation among dietary treatments ($P > 0.70$). Control pigs averaged a pen CV of 7.71% with 68% of the pigs between 107.4 and 125.3 kg, or a range of 8.97 kg. Pigs fed Paylean had a CV of 8.15% with 68% of the pigs between 110.1 and 129.6 kg, or a range of 9.75 kg. These findings suggest that Paylean (Ractopamine HCl) improves growth performance and feed efficiency of finishing pigs, but does not impact variation of growth.

Key Words: Ractopamine, Pigs, Variation

155 Growth performance and carcass characteristics of pigs fed diets containing a corn germ-corn bran product compared to diets composed of corn, soybean meal, and tallow. S. J. Kitt*, P. S. Miller, R. L. Fischer, and D. E. Reese, *University of Nebraska, Lincoln*.

A total of 240 mixed-sex, growing-finishing pigs were used to evaluate the feeding value of a corn germ-corn bran by-product. Pigs were blocked by weight (initial BW = 32.2 kg) and randomly assigned to one of four dietary treatments and allotted to pen (n = 24). Pigs and feeders were weighed biweekly to determine ADG, ADFI, and ADG/ADFI. Treatments were diets containing corn-soybean meal (CON), corn-soybean meal-4% tallow (TAL), corn-soybean meal-8% corn germ-corn bran (8% GERM), and corn-soybean meal-16% corn germ-corn bran (16% GERM). All diets met or exceeded the 1998 NRC requirements. During the 102-d trial, there were no differences among treatments for ADG ($P \geq 0.10$). Pigs fed TAL had a 5.3% decrease in ADFI ($P \leq 0.007$) and 8.7% improvement in feed efficiency (ADG/ADFI; $P \leq 0.005$) compared to all other treatments. Ultrasound scans revealed no differences ($P \geq 0.10$) in longissimus muscle area among treatments and an increased (2.57 vs 2.31 cm; $P \leq 0.02$) backfat depth for pigs fed TAL compared to other treatments. Calculated (NPPC, 1991) carcass lean percentage of pigs fed TAL was less (48.09 vs 49.02; $P \leq 0.06$) than the other treatments. Dressing percentage was greater ($P \leq 0.05$) for pigs fed diets containing TAL compared to pigs fed 8% GERM or 16% GERM. Pigs fed CON had greater ($P \leq 0.02$) subjective marbling score than pigs fed TAL and 16% GERM. Longissimus muscle pH of pigs fed CON tended to be greater (5.67 vs 5.60 vs 5.61, respectively; $P \leq 0.08$) than pigs fed TAL or 8% GERM. Subjective muscle firmness tended to be greater ($P \leq 0.09$) for pigs fed CON compared to all other treatments. Pigs fed TAL had greater ($P \leq 0.01$) longissimus muscle Minolta a* color score than other treatments. These data suggest that the feeding value of of corn germ-corn bran is lower than that predicted from its chemical composition.

Key Words: Pigs, Corn Germ, Corn Bran

156 The effect of body composition on dietary protein selection in finishing gilts. S. A. Meers*, R. Jones, T. D. Pringle, and M. J. Azain, *University of Georgia, Athens*.

The objective of this study was to determine if pigs of similar BW, but differing in tenth rib fat thickness, differ in their selection for dietary protein. The study was designed in a 2 × 2 factorial arrangement with main effects of body fat (Lean vs Fat) and diet (single vs choice). Crossbred gilts (n = 32) with an initial BW of 80 kg were sorted into high and low backfat groups based on real-time ultrasound scans at the 10th rib. Gilts in the low (Lean) and high fat (Fat) groups had 1.5 and 2.2 cm of 10th rib fat ($P < 0.001$) and 27.7 and 30.9 cm^2 loin area ($P < 0.05$), respectively, at the start of the study. Diets were: 1) a low-protein, corn-based diet that was supplemented with essential amino acids (EAA) such that all EAA were at, or above, the level suggested for an ideal pattern (8.5% CP, 0.58% Lys) and 2) a high protein, corn-soybean meal-based diet that was supplemented with Lys and Met such that it also had all EAA at or above an ideal pattern (22.7% CP, 1.275% Lys). During the first week, all pigs were fed a 50/50 mix of diets 1 and 2 (15.3% CP, 0.93% Lys). From d 7 to 28, one-half of the pigs in the Lean and Fat groups were given a choice of diets 1 and 2 in separate feeders. The position of the diets was rotated daily. The other pigs continued to be fed a 50/50 blend (single diet). Average daily gain (1.06 kg/d) and total intake (2.64 kg/d) were not different between treatment groups. However, the pattern of selection was different in the choice groups. Lean pigs consumed more (64.4%) of the high protein diet than did Fat pigs (35.6%, $P < 0.002$), resulting in a difference in the percent protein consumed. Lean pigs selected a 16.7% CP diet while Fat pigs selected a 12.6% CP ($P < 0.01$) diet. Thus, body composition influences diet selection. While allowing pigs to self select did not alter performance parameters, the results suggest that allowing individual animals to self-select may decrease the nitrogen intake and thus, cost of production. The implication of this work is that diet selection can be used to allow pigs to more closely meet their individual nutrient requirements.

Key Words: Diet Selection, Body Composition, Protein Intake

157 Effect of soy isoflavones on growth, carcass composition, pork quality, and plasma metabolites of growing-finishing barrows. R. L. Payne*, T. D. Bidner, and L. L. Southern, *Louisiana State University Agricultural Center, Baton Rouge*.

An experiment was conducted with 80 barrows to evaluate the effects of soy isoflavones (ISF) on growth, carcass composition, pork quality, and plasma metabolites. Average initial and final BW were 32.3 and 111.7 kg, respectively. The four diets were: 1) corn-soybean meal diet (C-SBM); 2) C-SBM + two times ISF content of C-SBM (2x ISF); 3) corn-soy protein concentrate diet (C-SPC, void of ISF); 4) C-SPC + ISF equal to ISF level in C-SBM (C-SPC+ISF). Each treatment was replicated five times with four barrows each in a randomized complete block design. Growth performance, carcass composition, and plasma metabolites were not affected ($P > 0.10$) in pigs fed 2x ISF diet compared with those fed C-SBM. However, b* color score was increased ($P < 0.10$) in pigs fed 2x ISF compared with those fed C-SBM. Overall ADG was decreased ($P < 0.10$) in pigs fed C-SPC diet compared to pigs fed C-SBM or 2x ISF, but the addition of ISF to the C-SPC returned ADG to a level similar to pigs fed C-SBM. Otherwise, growth of pigs fed C-SPC or C-SPC+ISF was not affected ($P > 0.10$) by diet. Average backfat was decreased ($P < 0.10$) in pigs fed C-SPC compared to those fed C-SBM. Pigs fed C-SPC+ISF had increased ($P < 0.10$) ultrasound and carcass measurements of 10th rib backfat thickness, average backfat, leaf fat, total fat, percentage fat, lean:fat, total ham fat, percentage ham fat, and butt fat thickness compared to those fed C-SPC. Percentage carcass lean and percentage ham lean were decreased ($P < 0.10$) in pigs fed C-SPC+ISF compared to pigs fed C-SPC. Pigs fed C-SPC+ISF had a higher ($P < 0.10$) 45-min pH compared to those fed C-SPC. Drip loss was decreased ($P < 0.10$) in pigs fed C-SPC+ISF compared to those fed C-SPC. Pigs fed C-SPC or C-SPC+ISF diets had a decreased ($P < 0.10$) insulin:glucose ratio compared to those fed C-SBM. The effects of isoflavones were variable, but they had little effect on growth, carcass composition, pork quality, or plasma metabolites of growing-finishing pigs.

Key Words: Soy Isoflavone, Pigs, Pork Quality

158 The effects of fructooligosaccharide on fecal pH and microbial activity in the yearling horse. E. L. Berg*, C. J. Fu, and M. S. Kerley, *University of Missouri, Columbia*.

The objective of the present study was to compare the effects of two different doses of dietary fructooligosaccharide (FOS) on colonic health in the horse, using fecal pH and fecal bacteria population as indicators. Nine yearling Quarter Horses were used in a 3 x 3 Latin square design and fed according to the 1989 NRC requirements. The diets were supplemented with no FOS (CON), 8 g FOS/d (LOW), or 24 g FOS/d (HIGH) over three 10-d feeding periods. Feces were collected the last three d of each 10-d period. Fecal pH was determined immediately following collection by submerging the pH probe in a mixture of equal amounts of feces and double distilled water. For later analysis of *E. coli* and *Lactobacilli* populations, feces were mixed with a glycerol salts solution (1:2), placed on ice, and then frozen at 80°C. Fecal color was recorded and fecal consistency scored (1 to 5 with 1 = extremely dry, 3 = normal, and 5 = diarrhea) with no differences ($P > 0.05$) found between treatments. Fecal pH was lower ($P < 0.05$) for the HIGH compared to the CON. Fecal *E. coli* population was lower ($P < 0.05$) for the LOW compared to both the HIGH and CON. No difference ($P > 0.05$) was found in fecal *Lactobacilli* population between treatments. Fructooligosaccharide supplementation at the level of 8 g/day decreased fecal *E. coli* population and pH without negatively affecting fecal consistency or color. These findings indicate a positive effect of FOS supplementation on gut health in the yearling horse.

Key Words: Fructooligosaccharide, Horses, Gastrointestinal Health

159 Effects of an intraperitoneal bolus injection of L-phenylalanine on physiological parameters in weanling pigs. K. Bregendahl*[1], L. Liu[1], M. Z. Fan[1], H. S. Bayley[1], J. P. Cant[1], B. W. McBride[1], L. P. Milligan[1], and J. T. Yen[2], [1]*University of Guelph, Guelph, ON,* [2]*U.S. Meat Animal Research Center, Clay Center, NE*.

Effects of an i.p. injection of Phe on concentrations of free AA, glucose, and insulin in plasma, and contents of free amino acids (AA) in tissue homogenates were assessed in pigs. Five blocks of five littermate gilts were weaned at 16 d of age and fed a pelleted starter diet (3340 kcal ME/kg, 1.2% true ileal digestible Lys). On d 8 post-weaning, L-Phe (1.5 mmol/kg BW) in saline (154 mM) was injected i.p. according to a randomized complete block design with euthanasia and tissue collection at 15, 30, 45, 60, or 75 min post-injection. Blood samples were collected immediately before Phe injection and euthanasia. Collected tissues were rinsed with ice-cold saline and frozen in liquid nitrogen. Free AA in plasma and tissue homogenates were measured with L-norleucine as an internal standard by gas chromatography-mass spectrometry after derivatization with hepta-fluorobutyrate. Plasma Phe increased logarithmically ($P < 0.05$) from 85 to 711 μM (836%) and reached 95% of the maximum concentration 48 min post-injection. Plasma Glu+Gln, Leu, and Lys concentrations decreased quadratically over time ($P < 0.05$), yet by no more than 28%. No other plasma AA changed over time ($P > 0.05$). Plasma glucose increased from 4.8 mM pre-injection to 5.8 mM 15 min post-injection and returned to pre-injection levels thereafter (cubic effect, $P < 0.05$). The plasma insulin concentration did not change over time ($P > 0.05$). Free Phe contents in cecum, colon, longissimus dorsi, distal small intestine, and stomach increased quadratically over time ($P \leq 0.05$), but did not change in heart, kidneys, liver, lungs, pancreas, proximal small intestine, and spleen. No changes in tissue free AA other than Phe were observed ($P > 0.05$). In conclusion, Phe injected i.p. quickly distributes into plasma and tissues with no or little effect on plasma glucose, AA, and insulin concentrations or on tissue free AA contents.

Key Words: Intraperitoneal Injection, Plasma Free Amino Acids, Tissue Free Amino Acids

160 Effects of dietary energy and lysine on growth performance and hormone profiles in finishing pigs. S. B. Cho*[1], J. S. Lim[2], I. B. Chung[1], S. H. Cho[1], Y. Y. Kim[2], and I. K. Han[2], [1]*National Livestock Research Institute, RDA, Korea,* [2]*Seoul National University, Korea*.

A total of 96 crossbred barrows (initial BW = 58.3 kg) were used to investigate the effect of various dietary energy and lysine levels on productivity and hormone profiles in finishing pigs. The experiment was conducted in a 2 x 4 factorial arrangement as a randomized complete block (RCB) design. Two energy levels (3,350 and 3,600 kcal DE) and four lysine levels (1.5, 1.8, 2.1 and 2.4 g/Mcal DE) were used in this experiment. Average daily feed intake of pigs was not influenced by the energy level, while dietary lysine level significantly influenced on ADFI ($P < 0.05$). Average daily gain was improved in the high energy treatments ($P < 0.05$) and was higher when pigs were fed high levels of lysine ($P < 0.05$). Feed efficiency (G:F) was higher ($P < 0.05$) when pigs were fed high dietary lysine or high energy throughout the whole experimental period. The concentration of IGF-1 was decreased in the low energy group and was lower when low lysine diets were provided, resulting in an interaction ($P < 0.01$). Leptin concentration tended to increase as dietary lysine level increased ($P < 0.05$), however, it was not affected by dietary energy. Carcass grade was not affected by dietary energy ($P = 0.12$) but was better as dietary lysine level increased ($P < 0.05$) resulting in an interaction($P < 0.05$). Water holding capacity (WHC) tended to increase as dietary lysine level increased ($P > 0.15$). The CIE values (L^*, a^* and b^*) were not affected by dietary energy or lysine level. The results indicated that feed efficiency could be improved by dietary energy and lysine level but carcass characteristics were not influenced by dietary treatments.

Key Words: Barrows, Energy, Lysine

161 Oat-based diets for market pigs in deep-bedded hoop barns. Z. M. Sullivan* and M. S. Honeyman, *Iowa State University, Ames*.

The objective was to determine the effects of the addition of dietary oats on performance and carcass traits of market pigs in deep-bedded hoop barns. A total of 36 pens of ten barrows each (3 diets × 2 pens/diet × 2 seasons × 3 replications) were fed. Summer season was May through September. Winter season was November through March. Barrows were started at 73 kg BW and fed until 123 kg BW. Pigs were weighed at 14-d intervals. Average daily gain, ADFI, and gain:feed ratio (G:F) were calculated. Backfat (BF) and loin eye area (LEA) were taken from the slaughter sheets. Three dietary treatments were fed ad libitum: 1) 20% oat diet, 2) 40% oat diet, and 3) control (corn and soybean meal). The oats were heavy test weight oats (minimum test weight of 16.4 kg/bushel). The diets were isolysinic (calculated basis). Prior to random allotment, pigs were fed together in a separate deep-bedded hoop barn. Oats fed to finishing pigs in hoop barns did not affect ADFI, ADG, or G:F. For winter, ADFI was 4.11, 4.15, and 4.04 kg/d ($P = 0.87$); ADG was 0.98, 1.03, and 1.00 kg/d ($P = 0.81$); G:F was 238, 247, and 249 g/kg ($P = 0.39$), for pigs fed the 20% oat diet, 40% oat diet, and control diet, respectively. For summer, ADFI was 3.54, 3.60, and 3.36 kg/d ($P = 0.87$); ADG was 0.96, 0.95, and 0.94 kg/d ($P = 0.81$); G:F was 271, 261, and 278 g/kg ($P = 0.39$), for pigs fed the 20% oat diet, 40% oat diet, and control diet, respectively. Feeding oats to finishing pigs in hoop barns did not affect carcass traits. For winter, BF was 22.0, 21.3, and 21.9 mm ($P = 0.98$); LEA was 43.2, 43.6, and 42.8 cm^2 ($P = 0.68$), for pigs fed the 20% oat diet, 40% oat diet, and control diet, respectively. For summer, BF was 23.4, 22.7, and 23.6 mm ($P = 0.98$); LEA was 42.5, 42.5, and 42.6 cm^2 ($P = 0.68$), for pigs fed the 20% oat diet, 40% oat diet, and control diet, respectively. Oats may be a suitable feedstuff for pigs in deep-bedded hoop barns.

Key Words: Pigs, Oats, Hoop barn

162 The effects of dietary calcium level and citric acid supplementation on growth performance and gastrointestinal pH in chicks. L. Peddireddi* and J. S. Radcliffe, *Purdue University, West Lafayette, IN*.

A total of 192 male broiler chicks were used in a 2 × 2 factorial design to study the effects of Ca level (0.6% or 1%) and citric acid addition (0 or 3 %) on growth performance and gastrointestinal pH. Birds were obtained on the day of hatch and randomly assigned to pens (6 birds/pen; 8 reps/diet). After a 1-wk adjustment period, dietary treatments were provided ad libitum for 2-wk. Pen BW and feed consumption were recorded weekly. On d13, excreta was collected for 24h. At the end of the 2-wk experimental period, all birds were fasted for two hours, refed for four hours, and killed by asphyxiation with CO_2. The contents of the proventriculus, gizzard, duodenum, jejunum, and ileum were removed for pH determination. The pH of excreta and intestinal samples was determined on a subsample of each mixed with deionized water, in a 1:10 ratio (wt:v). Diet titration values, calculated as: mEq

of NaOH/kg to pH 8 and mEq of HCl/kg to pH 4,were increased ($P < 0.05$) by increasing the level of dietary Ca, or by adding 3% citric acid to the diet. Body weight gain was unaffected ($P > 0.10$) by dietary Ca level, but adding 3% citric acid to the diet decreased growth rate ($P < 0.02$). There was a trend for decreased feed intake with higher dietary Ca levels ($P < 0.10$), but feed efficiency was not affected. Adding 3% citric acid to the diet decreased feed intake ($P < 0.05$) but did not affect feed efficiency ($P > 0.10$). Birds fed diets with higher Ca levels had an increased pH ($P < 0.05$) in the proventriculus, gizzard, duodenum, jejunum, and ileum. Adding 3% citric acid to diet had no effect ($P > 0.10$) on pH in the proventriculus, gizzard and ileum but decreased the pH ($P < 0.05$) in duodenum and jejunum. Excreta pH was higher ($P < 0.05$) in birds fed adequate levels of dietary Ca than in birds fed low levels of dietary Ca. The addition of 3% citric acid to the diet had no effect on excreta pH ($P > 0.10$). No interactions between dietary Ca level and citric acid addition to the diet were observed. Based on the results of this study, the level of Ca carbonate in the diet clearly affects physiological conditions within the gastrointestinal tract.

Key Words: Citric Acid, Calcium, Gastrointestinal pH

163 Effect of stage of lactation on colostrum and milk composition in multiparous sows.

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An experiment for measuring total milk solids (TMS) and CP of colostrum and milk from sows at different stages of lactation was conducted. Crude protein as a percentage of total milk solids at different stages of lactation was calculated as well. Thirteen sows (parity 6) originating from a triple cross mating of Yorkshire x Duroc x Landrace were used in this experiment. Litter size was standardized to 11 piglets per litter. Sows were fed a 14% CP corn-soybean meal based diet in gestation. In lactation, sows were fed an 18% CP corn-soybean meal based diet. During the initial 3 d of lactation, feed intake was restricted, but after that sows were allowed to consume their diets on an ad libitum basis. Both diets were formulated to meet or exceed the NRC requirements for all nutrients. The experimental period lasted 28 d, with milk being collected on d 0 (within 12 h of farrowing), 3, 7, 14, 21, and 28. One ml of oxytocin was administered intravenously (via the ear vein) to facilitate milk letdown. All functional teats on both sides of the sow mammary gland were hand stripped in succession and a total of 50 ml of mammary secretions were collected per collection date. Milk samples were analyzed for TMS and CP, and CP as a percentage of TMS was calculated. Sow performance data were also summarized and compared. Total milk solids decreased ($P < 0.002$) from 26.7% on d 0 to 23.1% on d 3. It further decreased ($P < 0.001$) to 19.3% on d 7, but after that, it remained constant ($P > 0.05$) at 18.2, 18.8, and 19.2% on d 14, 21, and 28, respectively. Milk CP decreased ($P < 0.001$) from 16.8% on d 0 to 7.7% on d 3. It further decreased ($P < 0.01$) to 6.2% on d 7, but after that, no changes ($P > 0.05$) were observed (5.5, 5.7, and 6.3% on d 14, 21, and 28, respectively). Throughout lactation, milk CP was positively correlated to TMS ($P < 0.05$). Changes in sow BW during lactation were correlated to ADFI ($P < 0.001$). The results of this study suggest that the TMS and CP concentrations of sow mammary secretions change during the first week of lactation, but after that it is constant. A positive correlation between TMS and CP exists. During lactating, ADFI is correlated to changes in sow BW.

Key Words: Sows, Lactation, Milk Composition

164 Effect of chromium source on tissue retention of chromium in pigs.

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The relative bioavailability of Cr from tripicolinate (CT), propionate (CP), methionine (CM) and yeast (CY) was evaluated by tissue Cr deposition in 40 crossbred finishing pigs (48 kg and 87 d of age). Pigs were blocked by gender and BW and randomly assigned to pens (gilts: 1/pen; barrows: 2/pen). The control corn-SBM diet (CONT) had no added Cr and met all NRC (1998) requirement estimates. Treatments used were CONT and CONT plus 5,000 ppb Cr from either CT, CP, CM or CY. Feed and water were supplied ad libitum during the study. Pigs were killed, carcasses processed, and tissue samples collected at a mean BW of 115 kg. Loin samples were taken after chilling the carcasses for 24h. Serum clinical chemistry evaluations at study termination were normal for all Cr forms. ADG for pigs fed CONT, CT, CP, CM and CY (0.864^a, 0.914^{ab}, 0.914^{ab}, 0.864^a, 0.936^b kg, respectively, $P < 0.05$) was relatively uniform as were ADF (2.48^a, 2.60^{ab}, 2.55^{ab}, 2.55^{ab}, 2.67^b kg, respectively, $P < 0.10$) and F/G (2.88, 2.86, 2.81, 2.95, 2.86 kg, respectively) for pigs fed the five diets. Tissue Cr (ng/g) results are provided below. Retention was highest in every tissue for CT, except for loin where there were no differences ($P > 0.10$). The largest increase in tissue concentration occurred in the ovary with CT (12-fold increase). In summary, the most consistent response in, and largest magnitude of, tissue deposition was with CT, indicating greater relative bioavailability of Cr in Cr tripicolinate.

	Diet					
Tissue	CONT	CT	CP	CM	CY	SEM
Bone	27^a	95^c	45^a	81^c	59^b	10.2
Kidney	42^a	185^c	61^{ab}	106^b	77^{ab}	16.2
Liver	12^a	91^b	21^a	41^a	14^a	14.4
Loin	96	151	219	82	205	84.8
Ovary	4^a	51^c	4^a	24^b	12^{ab}	5.0

$^{a,\ b,\ c}$ Means on each row without a common superscript differ, $P < 0.05$

Key Words: Pigs , Chromium, Mineral Nutrition

165 Effect of adding a bacillus-based direct fed microbial on performance of nursery pigs fed diets with or without antibiotics.

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The objective of this study was to evaluate the effect of a bacillus-based direct fed microbial (DFM) on performance of nursery pigs fed diets with or without antibiotics (AB). A total of 96 weanling pigs (4.3 kg BW) were blocked by initial weight and randomly assigned to one of four dietary treatments (trt), with six pens/trt and four pigs/pen. The trts were a 2 × 2 factorial arrangement, with two levels of DFM (0 vs 1.1 million spores per g of feed derived from BioPlus 2B) and two levels of AB (0 vs 35 g/ton of tiamulin and 400 g/ton of chlortetracycline). ADG, ADFI and G/F were measured throughout 5 phases ending at d 7, 14, 28, 42 and 56. Pigs were fed experimental diets through d 42 and then a common diet (containing no AB or DFM) through d 56. Feeds were pelleted through d 14 and meal thereafter. No interactions (Int) were observed between DFM and AB, indicating that this bacillus-based DFM and AB could have an additive effect. AB improved ADG ($P < 0.01$), ADFI ($P < 0.01$; data not shown) and G/F ($P < 0.07$) from d 0 to 56. Although DFM did not have a significant effect on performance from d 0 to 42, DFM increased ADG and G/F from d 0 to 56. This suggests that DFM could have a positive carryover effect on performance after its withdrawal. In summary, AB improved performance, and the addition of DFM tended to improve ADG and G/F for pigs fed diets with or without AB.

DFM	-	+	-	+			P values	
AB	-	-	+	+	SE	AB	DFM	Int
End weight, kg	29.7	32.1	33.4	34.4	0.70	0.001	0.03	0.32
ADG, g (d 0 - 14)	168	191	227	250	12.7	0.001	0.11	0.96
ADG, g (d 0 - 42)	390	409	468	486	12.2	0.001	0.22	0.98
ADG, g (d 0 - 56)	454	490	522	540	13.4	0.001	0.07	0.53
G/F (d 0 - 14)	0.85	0.89	0.95	1.02	0.03	0.001	0.07	0.90
G/F (d 0 - 42)	0.69	0.71	0.72	0.75	0.02	0.012	0.12	0.77
G/F (d 0 - 56)	0.60	0.62	0.63	0.64	0.01	0.066	0.08	0.63

Key Words: Pigs, Antibiotics, Direct Fed Microbial

166 Effect of dietary levels of soluble and insoluble fiber on embryo survival in gilts.

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Forty-three gilts were assigned randomly to one of four experimental diets to determine the effects of soluble (S) and insoluble (IS) dietary fiber on ovulation rate and embryo survival. Diets included corn-soybean meal control (C; 1.54% S, 7.97% IS), corn-soybean meal-30% oat bran high in S fiber (HS; 3.18% S, 8.03% IS); corn-soybean meal-13% wheat

straw high in IS fiber (HIS; 1.41% S, 15.63% IS); and corn-soybean meal-21% soybean hulls HS+HIS fiber (2.99% S, 20.80% IS). Gilts were housed in group pens (6 gilts/pen) by dietary treatment to facilitate twice daily estrus detection by a mature boar. On the first day of the second detected estrus, gilts were fitted with an auricular venous catheter to draw blood samples from estrus until 14 d after mating. At estrus, gilts were moved to individual crates and artificially inseminated three times using pooled semen. Daily feed was offered to gilts based on their initial body weight to meet their daily nutrient requirements (NRC, 1998) for ME (avg. = 5910 kcal), protein (avg. = 255 g), and lysine (avg. = 12.5 g). Reproductive tracts of gilts were harvested 32 d post-mating (range = 28 to 35 d). Statistical analysis of data included effects of diet and day of gestation as a covariate. Pregnancy rates were not affected ($P > 0.20$) by diet (9/12 C; 9/10 HS; 10/10, HIS; 9/11 HS+HIS). Number of corpora lutea was not affected by diet (avg. = 14.1; $P > 0.50$). Fertilization rate for gilts fed HS+HIS was lower than for gilts fed C, HS, and HIS (65.1 vs 84.3, 80.3, 76.4%; $P < 0.05$). Number of live embryos was lower for HIS and HS+HIS gilts compared to C and HS gilts (9.9 and 9.1 vs 11.9 and 10.6; $P < 0.05$). Survival rate of embryos was not influenced by dietary treatments (avg. = 97.3%; $P > 0.50$). High levels of dietary S combined with high levels of dietary IS fiber may decrease fertilization rate. However, under the conditions of this experiment, elevated dietary levels of S and(or) IS fiber did not affect ovulation rate or embryo survival rate.

Key Words: Gilts, Embryo Survival, Fiber

167 The optimal true ileal digestible threonine requirement for nursery pigs between 11 to 22 kg body weight.

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The objective of this 22-d growth assay was to determine the optimal true ileal digestible Thr:Lys ratio in nursery pig diets to maximize growth performance. A total of 380 pigs were randomly allotted to pens (5 pigs/pen and 7 pens/treatment) within blocks based on initial BW (approximately 11 kg). In a previous experiment, the true ileal digestible Lys requirement for these pigs was determined to be 1.2% and 1.3% for ADG and gain/feed (G:F), respectively. In this experiment, diets were formulated at and below the Lys requirement. The ten dietary treatments consisted of two basal diets (1.1 and 1.2% true ileal digestible Lys; 16.1 and 17.4% CP) with increasing levels of Thr (50, 55, 60, 65, and 70% of Lys). Pigs fed 1.2% true ileal digestible Lys had increased ($P < 0.01$) ADG and G:F compared to pigs fed 1.1% Lys, suggesting that the Lys requirement was greater than 1.1%. Increasing Thr had no effect ($P > 0.07$) on ADG. A Thr × Lys interaction ($P < 0.04$) was observed for G:F as pigs fed 1.1% Lys had a greater response to increasing Thr than pigs fed 1.2% Lys. Feed efficiency improved (quadratic, $P < 0.01$) for pigs fed increasing true ileal digestible Thr with the greatest improvement observed as the ratio increased to 60 and 65% of Lys for pigs fed 1.1 and 1.2% true ileal digestible Lys, respectively. These results suggest that the optimal true ileal digestible threonine requirement for 11 to 22 kg pigs is 60 to 65% of lysine.

	Threonine: Lysine, %				
Item	50	55	60	65	70
1.1% Lysine					
ADG, g	490	540	494	481	503
G:F	.55	.61	.64	.63	.65
1.2% Lysine					
ADG, g	540	553	540	531	544
G:F	.63	.65	.66	.68	.68

Key Words: Threonine, Lysine, Weanling Pigs

168 The use of soldier fly prepupae as a replacement for blood plasma in phase 1 and 2 nursery diets.

C. R. Dove*, G. L Newton, and D. C. Sheppard, *University of Georgia, Tifton.*

Two studies were conducted to determine if dried soldier fly prepupae (SF) could be used to replace blood plasma (BP) in nursery diets. In study 1, 84 pigs, weaned at 21 d of age, were randomly allotted to dietary treatment. Pigs were housed in an environmentally controlled nursery with ad libitum access to feed and water over the 35 d study. Experimental treatments were: 1) 5% BP during phase 1, 2.5% BP during phase 2 (PLA); 2) 2.5% BP, 2.5% SF during phase 1, 1.25% BP, 1.25% SF during phase 2 (COMBO); 3) 5% SF during phase 1, 2.5% SFL during phase 2 (SFP). All pigs were fed a common phase 3 diet with no BP or SF. The SF were produced on swine and poultry manure, resulting in over a 50% reduction of manure DM. In study 2, 105 pigs were weaned, housed and managed as in study 1. Dietary treatments were the same, except that dietary Lys, Thr, Trp and Met concentrations were equalized across diets. In both studies, data was analyzed using SAS Mixed Models procedures, with the pen as the experimental unit. In study 1, pigs fed SFP tended to have decreased ADG during phase 1 and had decreased ($P < 0.05$) ADG during phase 2. During phases 1 and 2 of study 1, pigs fed SFP had decreased ($P < 0.05$) ADFI. Pigs fed COMBO had ADG and ADFI similar ($P > 0.1$) to pigs fed PLA during phases 1 and 2. Over the 35 d study, ADG was decreased ($P < 0.05$) in pigs fed SFP compared to those fed PLA, with the COMBO diet being intermediate. ADG for the 35 d study 1 was 383, 369, and 331 g/d for the PLA, COMBO and SFP diets, respectively. Feed efficiency was not affected ($P > 0.1$) by the COMBO or SFP treatments compared to pigs fed PLA in study 1. In study 2, pigs fed SFL had decreased ($P < 0.05$) ADG compared to the PLA or COMBO fed pigs during phase 1. During phase 2 and 3 of study 2, both the SFP and COMBO fed pigs had decreased ($P < 0.05$) ADG compared to the PLA fed pigs. Daily feed intake was decreased ($P < 0.05$) in pigs fed SFP during phases 1 and 2 in study 2 compared to the PLA or COMBO fed pigs. Gain:feed ratio was decreased ($P < 0.01$) in pigs fed the COMBO diet during phase 3 and over the entire 35 d study. The data from these studies indicate that SFP can be used to replace 50% of the BP in phase 1 nursery diets and that supplementation of SF diets with amino acids did not improve pig performance.

Key Words: Pigs, Soldier Fly Prepupae, Growth

169 Efficacy of mannan oligosaccharide supplementation through late gestation and lactation on sow and litter performance.

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A previous experiment evaluating mannan oligosaccharide (MOS) supplementation to sows in a commercial facility reported improvements in milk immunoglobulin (Ig) levels, d to estrus, birth weight, and weaning weight. This study was conducted to confirm the efficacy of MOS supplemented in a commercial facility during late gestation and throughout lactation on sow and litter performance. The experiment was conducted on a 600-sow farrow-to-wean commercial facility. A total of 318 sows were administered treatments during the last 21 d of gestation and through lactation. Treatments included control sows and MOS-supplemented (5 g of MOS/d) sows. Sows were fed standard diets and treatments were top-dressed by providing a placebo or treatment bolus immediately at feeding. On d 10 after farrowing, litters were scored for scours using a 1 to 5 scale, such that 1 = watery stool and 5 = firm stool. Additionally, a 5-mL milk sample was obtained from 15 sows/treatment prior to the time that pigs nursed and was analyzed for IgA, IgG, and IgM. Sow records from 3 wk after the study was completed were used to determine d to estrus. There was no difference ($P \geq 0.10$) in number of pigs born alive, birth weight, Ig levels, or number of pigs weaned between sows supplemented with MOS and control sows. The percentage of litters with a scour score of 5 was similar between treatments. However, of the litters with scour scores of 1, 2, 3, or 4, 38.7% of these were in the MOS-supplemented group compared to 61.3% in the control group (Chi-square, $P = 0.10$) Although not statistically significant ($P \geq 0.10$), litter weaning weight (55.6 vs 57.5 kg), and d to estrus (6.4 vs 5.9) were improved when sows were supplemented with MOS compared to control sows. Results of this study suggest that MOS supplemented to sows during gestation and lactation may benefit sow and litter performance and warrants further investigation.

Key Words: Pigs, Sows, Mannan Oligosaccharides

170 Effect of increasing corn oil on apparent amino acid digestibility of soybean meal.

J. W. Frank* and G. L. Allee, *University of Missouri , Columbia.*

A study was conducted to evaluate the effect of corn oil on apparent digestibility (AD) of amino acids in soybean meal (SBM). This experiment was designed as two - 6 × 6 Latin Squares using ileal-cannulated pigs (average BW = 74.2 kg). The first diet contained 34.1% SBM (48%

CP) with 2% corn oil. Three additional diets with the same level of SBM included increasing levels of corn oil resulting in total corn oil contents of 5, 8, and 11%. The corn oil replaced cornstarch, while all other ingredients remained the same as the first diet. An additional diet contained soy protein concentrate (SPC), which replaced SBM on an isolysine basis. The final diet contained casein as the protein source. The SPC and casein diets included 2% corn oil. Apparent amino acid digestibility was calculated using chromic oxide in the diet as an indigestible marker. The diet containing SBM had consistently greater AD of essential amino acids than SPC ($P < 0.05$). These amino acids included isoleucine (83.2 vs 80.6%), leucine (83.0 vs 79.5%), methionine (85.4 vs 81.6%), and threonine (76.4 vs 69.4%). In addition, the AD of amino acids in SBM was greater than casein for arginine, isoleucine, tryptophan, and threonine ($P < 0.05$). No differences in the AD of lysine were observed among the three protein sources (84.8, 82.5, and 84.9% for SBM, SPC, and casein, respectively). The AD of amino acids of the SBM used in this trial agree with the values reported in the NRC; however, the AD values for SPC and casein were lower than reported in the NRC. No improvement in AD in SBM was observed with increasing dietary corn oil from 2% to 11% for any of the amino acids measured. These results demonstrate further processing of soybean meal to soy protein concentrate does not improve apparent amino acid digestibility and increasing the level of corn oil in the diet does not significantly increase apparent amino acid digestibility of soybean meal.

Key Words: Pigs, Digestibility, Amino Acids

171 Growth performance, carcass characteristics, and pork color in finishing pigs fed two sources of supplemental iron. K. L. Saddoris*[1], T. D. Crenshaw[1], J. R. Claus[1], and T. M. Fakler[2], [1]*University of Wisconsin, Madison,* [2]*Zinpro Corporation, Eden Prairie, MN.*

The potential for two iron sources to induce a pork color change was evaluated in pigs. 72 pigs (D×LR×LW) ∼70 kg were randomly assigned to dietary treatments. Treatments consisted of a corn-soybean meal Control diet (50 ppm Fe added from iron sulfate), Control + 90 ppm Fe from iron sulfate, and Control diet + 90 ppm Fe from Availa-Fe 60. Three trials were conducted, each with 2 pens/treatment and 4 pigs/pen, and pen was used as the experimental unit. Pigs were fed their diets for 47 d and then slaughtered. Carcass traits were assessed at 24 h postmortem. Loin color and purge loss was assessed during a 7 d storage (2-3°C), and Minolta and reflectance spectrophotometry measurements were made on d 1, 3, 5, 7. Differences among dietary treatments were not detected ($P > 0.10$) in ADG, ADFI, or gain:feed ratio. Backfat, LEA, loin pH, and 24 h L∗ and b∗, and subjective color, marbling, and firmness scores did not differ ($P > 0.10$) among treatment groups. The 24 h a∗ value was lower ($P < 0.05$) for pigs fed the iron sulfate diet compared to the control. During storage, L∗, b∗, and estimated deoxymyoglobin, metmyoglobin, and oxymyoglobin did not differ ($P > 0.10$) among treatment groups. Availa-Fe 60 increased ($P < 0.05$) a∗ values on d 1, 3, 5, 7 compared with the iron sulfate fed groups, and increased ($P < 0.05$) a∗ values on d 3, 5, 7 compared with the control fed groups. Iron sulfate decreased ($P < 0.05$) a∗ value on d 1 of storage compared to pigs fed the control and Availa-Fe 60 diets. Purge loss was decreased ($P < 0.05$) by pigs fed iron sulfate (4.82%) and Availa-Fe 60 (4.64%) compared to the control (5.40%). In conclusion, 90 ppm of both iron sulfate and Availa-Fe 60 had no beneficial effects on growth, carcass composition, or 24 h pork color. On d 7 of storage, Availa-Fe 60 increased redness 5.3% compared to pigs fed the control diet (a∗ 7.86 control vs 8.28 Availa-Fe). Iron supplementation of 90 ppm from iron sulfate or Availa-Fe 60 resulted in a 10-15% reduction in purge loss over the 7 d storage.

Key Words: Pigs, Color, Iron

172 The effect of a calcified seaweed product on growth performance, carcass traits, and meat quality in swine. D. W. Dean*, L. L. Southern, and T. D. Bidner, *Louisiana State University Agricultural Center, Baton Rouge.*

Two experiments were conducted to determine the effects of a calcified seaweed product (CSP) in diets for pigs. The CSP (Marigro) contained 30% Ca (100% bioavailable as previously determined) and was added at the expense of limestone in both experiments. In Exp. 1, 64 crossbred barrows and gilts (76.9 kg average initial BW and 110.6 kg average final BW) were blocked by weight and allotted to pens based on sex and ancestry. There were four replications of barrows and four replications of gilts with four pigs/replicate. The pigs were fed diets containing 0 or 0.50% CSP in a 57-d growth assay. Growth performance and carcass traits were not affected by CSP ($P > 0.10$). Minolta L* and b* values were increased by CSP ($P < 0.05$). However, there were no effects on initial and final pH, drip loss, or subjective color and marbling scores of the longissimus muscle ($P > 0.10$). In Exp. 2, 150 weanling barrows and gilts (5.7 kg average initial BW) were allotted to three treatments and used in a 178-d growth assay. Each treatment was replicated 10 times (five replications/sex) with five pigs/replicate for the nursery phase (d 0 to 33). After the nursery, the five replications of gilts were continued on their dietary treatments until slaughter (117.3 kg average final BW). Pigs were fed 0, 0.25, or 0.50% CSP. Overall rate and efficiency of gain in the nursery period were linearly decreased ($P < 0.08$) by CSP; however CSP did not affect ($P > 0.10$) growth performance in the growing and finishing periods. Carcass lean and fat measurements as well as pork quality measurements were not affected ($P > 0.10$) by CSP. These results suggest that CSP may be substituted for limestone through the growing and finishing phases with no adverse effect on growth or carcass traits.

Key Words: Pork Quality, Carcass, Seaweed

173 Influence of dietary energy on growth performance of the late nursery pig. C. Hastad*, M. Tokach, J. Nelssen, S. Dritz, R. Goodband, and J. DeRouchey, *Kansas State University, Manhattan.*

Two studies were conducted to evaluate the effects of increasing energy density in nursery pig diets. In Exp. 1, 200 pigs with an initial BW of 13.7 kg were used in a 21-d growth assay. Pigs were allotted to one of five dietary energy levels of 3,047, 3,157, 3,268, 3,378, and 3,489 kcal of ME/kg. Energy densities were achieved by substituting wheat bran or soybean oil for corn in the corn-soybean meal based diets. All diets were formulated to 1.30% true digestible lysine. Overall, increasing dietary ME resulted in a linear increase in ADG ($P < 0.02$; 703, 714, 728, 735, and 753 g/d) and gain/feed ($P < 0.01$; 0.64, 0.63, 0.67, 0.67, 0.69). Experiment 2 was conducted at a commercial nursery facility in southeast MN. We used 1,415 pigs with an initial BW of 11.8 kg in a 21-d growth assay. Pigs were fed corn-soybean meal diets with increasing amounts of choice white grease (0, 1.5, 3, 4.5, and 6%). All diets were formulated to contain 4.5 g total lysine/Mcal ME. From d 0 to 7, ADG increased (quadratic $P < 0.01$; 495, 531, 564, 544, 522 g/d) with increasing dietary energy with the largest improvement observed when 1.5% fat was added to the diet. Feed intake decreased (linear, $P < 0.02$; 714, 716, 725, 695, 678 g/d) and G:F improved (linear, $P < 0.01$; 0.69, 0.74, 0.78, 0.78, 0.77) with increasing energy. For d 7 to 14 and 14 to 21, increasing energy reduced ($P < 0.01$) ADFI and improved G:F ($P < 0.01$); however, there was no difference ($P > 0.23$) in ADG. Overall, increasing dietary energy reduced ADFI (linear, $P < 0.01$; 887, 876, 856, 834, 822 g/d) and improved feed efficiency (linear, $P < 0.01$; 0.64, 0.67, 0 .68, 0.70, 0.71); however, ADG was not affected ($P > 0.26$; 564, 583,583, 580, 582 g/d). These studies indicate that increasing dietary energy for nursery pigs during the late nursery phase linearly improves feed efficiency; however, the effect on ADG is less consistent.

Key Words: Pigs, Energy, Fat

174 Monitoring the effects of ractopamine in market hogs, the effects on barrows and gilts. B. S. Zimprich* and M. J. Marchello, *North Dakota State University, Fargo.*

Twenty-four crossbred barrows and twenty-four crossbred gilts were randomly assigned to diets at 86 kg BW. The pigs were housed in individual pens in a climate-controlled room. Corn-soybean meal diets for the barrows contained 14% CP and 0.7% Lys (BLL); 14% CP and 1.2% Lys (BHL); 14% CP and 1.2% Lys plus ractopamine at 10 ppm (BHLR); or 16% CP and 1.05% Lys plus ractopamine at 10 ppm (BR). Diets for the gilts consisted of 15% CP and 0.7% Lys (GLL); 15% CP and 1.2% Lys (GHL); 15% CP and 1.2% Lys plus ractopamine 10 ppm (GHLR); or 16% CP and 1.05% Lys plus ractopamine at 10 ppm (GR). Pigs were maintained on the respective treatment diets for four wk, pigs were then slaughtered and carcass data was collected. Barrows on BHLR diet ended the collection period heavier than barrows on diet BLL (117 vs 111.62 kg, $P < 0.01$). Pigs on BHLR and the BR diets had a higher ADG than pigs on the BLL diet (0.92, 0.90 vs 0.75 kg; $P < 0.04$). Barrows on BHLR and BR diets had a more desirable g:f than barrows

on BLL treatment (310.7, 310.7 vs 262.2 g/kg; P < 0.005). Gilts on GHLR and GR treatments also had a higher improvement in g:f than gilts on GLL diet (326.3, 331.1 vs 381.7 g/kg; P < 0.02). Barrows on treatments BHLR and BR had an increase in loin eye area over barrows on treatments BLL and BHL (56.58, 51.74 vs 44.26, 46.19 cm^2; P < 0.05). BHLR barrows had a higher percent lean than barrows on treatments BLL and BHL (58.69 vs 54.64, 55.32%; P < 0.03). BR and GR were identical diets and there were no differences found between barrows and gilts fed those respective diets. We have found that protein levels can be reduced if lysine levels are maintained with the result of obtaining performance and carcass results comparable to those achieved when manufacture recommendations are followed.

Key Words: Ractopamine, Lysine, Growth Performance

175 Effects of ractopamine and β-mannanase addition to corn-soybean meal diets on growth performance and carcass traits of finishing pigs. J. D. Schneider*, S. D. Carter, T. B. Morillo, and J. S. Park, *Oklahoma State University, Stillwater.*

An experiment using 96 pigs (avg BW = 79.1 kg) was conducted to evaluate the effects of ractopamine (RAC; Paylean®, Elanco Animal Health) and β-mannanase (Hemicell®, HC; ChemGen Corp.) addition to corn-soybean meal diets on growth performance and carcass traits of finishing pigs. Previous research from our lab suggest that HC increases growth performance in pigs. Pigs were blocked by weight and sex, and allotted randomly to four dietary treatments (6 pens/trt). Dietary treatments were: 1) a fortified corn-soybean meal diet, 2) as Diet 1 with 10 ppm RAC, 3) as Diet 1 with 0.05% HC, and 4) as Diet 1 with 10 ppm RAC and 0.05% HC. All diets were formulated to 1.0% Lys, .60% Ca, and .50% P. Pigs were housed (4 pigs/pen) in a temperature-controlled finishing facility and allowed ad libitum access to feed and water. Pigs and feeders were weighed at 7-d intervals. Average daily gain and gain:feed (G:F) for the four treatments were, respectively: 0.81, 0.94, 0.79, 0.95 kg/d and 0.28, 0.35, 0.28, 0.34 kg/kg. Addition of RAC increased (P < 0.01) ADG and G:F, but HC had no effect (P > 0.10) on growth performance. There were no differences (P > 0.10) in ADFI, and no interactions (P > 0.10) were noted for growth performance. At approximately 113 kg BW, pigs were killed and carcass measurements were recorded. Tenth rib fat depth (FD), average backfat (ABF), longissimus muscle area (LMA), and % lean were, respectively: 1.68, 1.52, 1.63, 1.45 cm; 2.18, 2.13, 2.21, 1.98 cm; 45.9, 48.8, 46.2, 50.3 cm^2; and 55.0, 56.1, 55.4, 57.1%. Addition of RAC decreased (P < 0.02) ABF and FD, and increased (P < 0.01) LMA and % lean. Hemicell had no effect (P > 0.10) on carcass traits. Although there were numerical improvements in carcass traits when HC was added to the RAC diet, there were no interactions (RAC × HC, P > 0.12). These results suggest that Hemicell had no effect during the late-finishing phase. However, ractopamine markedly improves growth performance and carcass traits.

Key Words: Pigs, Ractopamine, β-mannanase

176 Effects of reducing metabolizable energy concentration in diets containing spray-dried porcine plasma on weanling pig performance. T. B. Morillo*, S. D. Carter, S. Genova, J. S. Park, and J. D. Schneider, *Oklahoma State University, Stillwater.*

Two experiments were conducted to determine the effects of reducing the ME concentration of diets containing spray-dried porcine plasma (SDPP) on weanling pig performance. In both experiments, pigs (avg BW = 5.8 kg) were weaned at approximately 21 d and housed (6-7 pigs/pen) in a temperature-controlled nursery for 18 d. Pigs and feeders were weighed on d 0, 7, 14, and 18 to determine ADG, ADFI, and gain:feed (G:F) ratio. In Exp. 1, 232 pigs were blocked by weight and randomly allotted to four dietary treatments (9 pens/trt). Diet 1 (3,471 kcal ME/kg) was composed primarily of corn, soybean meal, dried whey, lactose, soy protein concentrate (SPC), fish meal, and soybean oil. Diet 2 (3,471 kcal/kg) was similar to Diet 1 with the exception that SDPP replaced SPC. Diets 3 and 4 were similar to Diet 2 except that soybean oil decreased to provide 3,371 and 3,271 kcal ME/kg, respectively. All diets contained 1.35% digestible Lys. Pigs fed SDPP had greater (P < 0.01) ADG, ADFI, and G:F than pigs fed SPC from d 0 to 18. Decreasing the ME in SDPP diets had no effect (P > 0.10) on growth performance, but it increased (linear, P < 0.01) gain/ME intake. In Exp. 2, 168 pigs were allotted to four dietary treatments (7 pens/trt) in a 2 × 2 factorial design with two CP sources (SPC vs SDPP) and two ME levels (3,523 vs 3,323). Diet composition was similar to Exp. 1. Pigs fed SDPP tended to have greater (P < 0.08) ADG, ADFI, G:F, and gain/ME intake than pigs fed SPC from d 0 to 18. Reducing ME had no effect (P > 0.10) on growth performance, but it increased (P < 0.10) gain/ME intake. The improvements in G:F and gain/ME intake associated with reducing ME of the diet tended to be greater for pigs fed SPC than for pigs fed SDPP (CP source × ME level, P < 0.10). These results suggest that lowering ME in SDPP diets does not affect growth performance of weanling pigs; however, the source of dietary protein may affect energy (fat) utilization.

Key Words: Pigs, Plasma Protein, Metabolizable energy

177 Factors related to insulin function in sows: response to chromium-L-methionine. V. G. Pérez-Mendoza*[1], J. A. Cuarón[1], T. L. Ward[2], and T. M. Fakler[2], [1]*C.N.I. Fisiología y Mejoramiento Animal, INIFAP, Queretaro, Mexico,* [2]*Zinpro Corp., Eden Prairie, MN.*

Metabolic response to insulin is naturally diminished during gestation and it could be aggravated by over-feeding of carbohydrates, particularly from soluble sources. Results of two experiments are presented to contribute to the distinction of the response of sows to the correction of a Cr deficiency. In Exp. 1, 36 sows were fed 3 isoenergetic (ME, 3.3 Mcal/kg), isolysinic (0.8% digestible Lys) diets to challenge the response in feed intake. Diets were: Control (CTR), 12% sucrose (SUC) and a sweetened Control (artificial flavoring agent, AFA), to equal the sweetening power of sucrose and molasses. Feed intake was improved (P < 0.14) by SUC (5.4 kg), but not by AFA (4.9 kg) over CTR (4.7 kg). Litter weaning weight tended to increase as a direct response to feed intake: CTR, 52.5; SUC, 58.7 and AFA, 52.3 kg, but prolificacy in the subsequent farrowing was unchanged (9.5 live pigs). In Exp. 2, obesity was induced from Day 70 of gestation by feeding 10 vs. 5.9 Mcal of ME/d. Chromium from chromium-L-methionine (CrMet; MiCroPlex®, Zinpro Corp.) was added (400 ppb Cr) from Day 109 of gestation until the subsequent mating for the CrMet treatment group. A total of 144 sows were used in the factorial arrangement of treatments (main effects of diet energy level and Cr addition). Lactation diets were formulated to contain 3.3 Mcal of ME/kg, 0.85% digestible Lys, and 12% sucrose. Diets were fed *ad libitum*. Over-fed sows were heavier (P < 0.04) at farrowing (233 vs. 209 kg) and had smaller (P < 0.02) litter size at weaning (8.6 vs. 9.4 piglets). Main effects of Cr supplementation were greater (P < 0.01) feed intake in lactation (5.4 vs. 4.6 kg/d); lower (P < 0.10) lactation weight loss (18.6 vs. 25.4 kg) and greater (P < 0.16) litter weight gain to weaning (45.3 vs. 42.2 kg). Obesity and Cr interacted (P < 0.03) in backfat change during lactation: obese-control sows lost 12 mm, which was prevented by CrMet supplementation (-4.6 mm), while non-obese sows were unaffected (-7.1 mm). Feeding chromium-L-methionine to sows improves reproductive performance.

Key Words: Sows, Chromium, Obesity

178 Lactating and rebreeding sow performance in response to chromium-L-methionine. V. G. Pérez-Mendoza*[1], J. A. Cuarón[1], C. J. Rapp[2], and T. M. Fakler[2], [1]*C.N.I. Fisiología y Mejoramiento Animal, INIFAP, Queretaro, Mexico,* [2]*Zinpro Corp., Eden Prairie, MN.*

Productive performance of lactating and rebreeding sows (182 Duroc-Landrace sows) was measured in response to Cr supplementation from chromium-L-methionine (CrMet; MiCroPlex®, Zinpro Corp.). At Day 109 of gestation, sows were moved to the farrowing house, where pelleted lactation diets were fed at 2.0 kg/d prior farrowing and *ad libitum* during lactation. Lactation diets were based on sorghum-soybean meal with added fat formulated to contain 3.31 Mcal of ME/kg and 0.85% digestible Lys. Treatments were the addition of CrMet, to the lactation diet at 0, 200 and 400 ppb Cr from farrowing until rebreeding (up to 24 d postweaning). Litter size was adjusted to a minimum of 10 piglets within 48 h postfarrowing. Lactation length was an average of 20.7±2 days in an all in-all out system. Creep feed was not offered to the piglets. After weaning, all animals were fed 2.0 kg/d of the appropriate lactation diet in collective breeding pens. After breeding, sows were fed the gestation diet (meal form). Days to estrus and days to conception were recorded. Sows that failed to exhibit estrus in 21 d after weaning were considered anestrus. Prolificacy at the subsequent farrowing was measured. Data were analyzed as a randomized block design; farrowing group was the blocking criteria. Parity effects were considered in the

model. There were no interactions (P > 0.30) with sow parity. Sow body weight and composition (backfat and muscle depth) were not affected by Cr (P > 0.42), although lactation feed intake was increased (P < 0.15) by Cr (5.6 vs. 5.9 kg/d), as were piglets weaned (0, 8.8; 200, 9.4 and 400, 9.1; P < 0.16), litter weaning weight (0, 52.2; 200, 55.8 and 400, 55.3 kg; P < 0.2) and days to estrus (0, 6.9; 200, 6 and 400, 6.1; P < 0.16). Chromium supplementation improved (P < 0.01) prolificacy at the subsequent farrowing (0, 9.6; 200, 11; and 400, 10.9 piglets born alive per litter). Chromium-L-methionine is an available source of Cr, improving reproductive performance of sows.

Key Words: Sows, Chromium, Prolificacy

179 Effects of short chain fructooligosaccharides and tylosin (Tylan®) on performance and fecal bacterial populations of nursery pigs.

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An experiment using 480 weaned pigs (average initial BW = 6.7 kg) entering a conventional nursery facility was conducted to evaluate the effects of graded levels of short chain fructooligosaccharides (SCFOS) fed alone or in combination with tylosin (Tylan®). The objective was to compare performance and fecal bacterial populations between pigs consuming either a prebiotic (SCFOS)or a sub therapeutic level of antibiotic (tylosin). Pigs were weighed, ranked according to BW, and assigned to pens. One of six treatments was randomly assigned to a pen. Treatments were a 2 x 3 factorial arrangement of two levels of tylosin (0 or 100 g/907 kg of feed) and three levels of SCFOS (0%, 0.1%, 0.2%). Each treatment was replicated four times. Data was analyzed as a 2 × 3 factorial using the SAS mixed model. The 43-d experiment was divided into 3 phases of 14 d, 14 d, and 15 d, respectively. Diets were complex and were changed at the beginning of each phase. Feed intake was affected by SCFOS in Phase 1 and for the entire study (P = 0.10 and P = 0.07, respectively). Pigs fed 0% or 0.1% SCFOS had higher ADFI than pigs fed 0.2% SCFOS. Average daily gain was affected by SCFOS for the entire study (P = 0.08) with 0.1% SCFOS pigs having higher ADG than 0.2% SCFOS pigs; however, ADG of 0% SCFOS pigs was intermediate to the other two treatments. Consumption of tylosin improved ADFI (P = 0.0006) and ADG (P = 0.02) during Phase 2 and tended to increase ADG (P = 0.12) in Phase 1 and for the entire experiment (P = 0.18). Pigs fed tylosin also tended to have improved feed efficiency (P = 0.18) during Phase 1. Fecal samples were collected at the end of the study and analyzed for *Lactobacilli*, *Bifidobacterium* and *Salmonella* species. Level of SCFOS tended (P = 0.17) to affect concentration of *Lactobacilli*, with 0% SCFOS having a higher concentration than 0.1% and 0.2% SCFOS. No *Salmonella* were detected and the presence of *Bifidobacterium* could not be verified. These data suggest that sub therapeutic antibiotics and prebiotics may have limitations in boosting performance of nursery pigs.

Key Words: Prebiotic, Tylosin, Nursery Pigs

180 Evaluation of commercial nursery starter programs on early nursery performance.

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An experiment was conducted to determine if differences existed in pig performance due to different nursery starter recommendations. A total of 644 Genetiporc pigs weighing 5.02 kg were allotted to 7 programs (n = 9). Pigs were fed according to manufacturer recommendations with 4 of the 7 starter programs having an equivalent amount of feed budgeted (Trt A, B, C, and D; budgeted .45 kg, 1.36 kg, and 5.44 kg/pig of the Nursery 1, Nursery 2, and Nursery 3 diets, respectively). Nursery diets ranged in CP content from 22.2% in the Nursery 1 diet to 20.6% in the Nursery 4 diet. All nursery diets were similar for Ca (1.09%) and P (0.83%). Pigs were approximately 20 d of age at weaning, and allowed ad libitum access to feed and water. Pigs were weighed at d 0, 4, 11, and 25 postweaning. Treatments B, D, and E had similar performance overall, with treatments C and F, which were not fed a prestarter, having the lowest performance overall. Average daily gain ranged from 193 g to 300 g from d 0 to 11 in the nursery, with pigs gaining at a higher rate having a higher feed intake. Gains from d 11 to 25 were more similar with ADG ranging from 373 g to 489 g, with ADFI being higher for those pigs gaining the fastest. Overall performance d 0 to 25 in the nursery resulted in a spread of d 25 BW between the programs with values represented being (14.23, 14.55, 12.90, 14.64, 14.70, 13.49, and 13.93 kg, respectively). The results of this experiment suggest that even in fast growing, high feed intake pigs, differences between commercial nutrition programs can be observed.

	Trt A	Trt B	Trt C	Trt D	Trt E	Trt F	Trt G
# Observations	9	9	9	9	9	9	9
Days 0 to 25 Postweaning							
ADG, g	368.9	382.2	315.9	384.7	386.8	338.3	356.1
ADFI, g	484.8	514.3	430.9	478.3	504.9	485.3	459.7
GF	0.76	0.75	0.73	0.81	0.77	0.70	0.78
Total Gain, kg	9.22	9.56	7.89	9.62	9.67	8.46	8.90

$P < .001$.

Key Words: Starter, Nursery, Pigs

181 Evaluation of prestarters from d 0 to 4 post-weaning.

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Two experiments were conducted to determine prestarter influence on nursery pig performance. Experiment 1 used a total of 280 Genetiporc pigs weighing 4.7 kg, allotted to one of two commercial prestarters (n = 14). Pigs were fed the prestarters from d 0 to 4 in the nursery, and had ad libitum access to feed and water. Gain was higher for prestarter B than in Prestarter A (222 vs 183 g/d; P = .06). No differences were observed for G:F, but ADFI was higher for Prestarter B than Prestarter A (202 vs 183 g; P = .05). Experiment 2 used a total of 644 Genetiporc pigs weighing 5.02 kg, allotted to one of 7 treatments, 5 prestarters (A, B, D, E, and G) and 2 Nursery 1 diets (C and F, not classified by manufacturer as a prestarter), as recommended from d 0 to 4. All diets were fed based on manufacturer recommendations from d 0 to 4. Prestarter A and B were the same prestarters fed in Exp. 1. All pigs except for treatments E and F had switched to the second phase diet by d 4. Pigs fed the 5 prestarters had greater gains (292.8 vs 255.4 g/d, respectively) and G:F (1.68 vs 1.49, respectively), than pigs fed the Nursery 1 diets. Intakes were similar (176 vs 172 g/d). Similar differences in ADG between Prestarters A and B were observed in both Exp. 1 and 2 (39 g/d and 37 g/d; respectively). These results indicate that differences exist in high quality Prestarters that can influence performance from d 0 to 4 post-weaning.

Exp. 2	Trt A	Trt B	Trt C	Trt D	Trt E	Trt F	Trt G	P <
# Observations	9	9	9	9	9	9	9	
D 0 to 4								
ADG, g	286	323	276	250	289	234	316	.01
ADFI, g	178	195	178	149	166	166	194	.001
G:F	1.64	1.67	1.57	1.71	1.45	1.41	1.63	.18
Total gain, kg	1.14	1.29	1.11	1.00	1.16	0.94	1.27	.01

Key Words: Prestarter, Nursery, Pigs

182 The effect of feed intake on amino acid digestibility in growing pigs.

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Six growing barrows (initial BW = 108 kg) were used in an experiment to determine the effect of level of feed intake on the digestibility of CP and amino acids (AA). All pigs were equipped with a T-cannula in the distal ileum. Two experimental diets were formulated. Diet 1 was a soybean meal cornstarch-based diet. Diet 2 was a cornstarch dextrose-based N-free diet used to estimate the endogenous flow of CP and AA to the distal ileum. Chromium oxide (0.25%) was included in both diets as an inert marker. Each diet was fed at a level calculated to equal the maintenance requirement of the pig (M1), at two times the maintenance requirement (M2), and at three times the maintenance requirement (M3) providing for a total of six different dietary treatments. The pigs were arranged in a 6 × 6 Latin square design with six periods and six dietary treatments. Each period lasted 7 d with the initial 5 d being an adaptation period to the treatment. Samples of ileal digesta were collected for two 12-h periods on d 6 and 7. Results of the experiment showed that

the apparent ileal digestibility coefficient (AID) for CP and all indispensable AA except Lys, Met, and Val were higher ($P < 0.05$) for pigs fed at M2 as compared to M1. Higher AID for M2 compared to M1 were also calculated for Cys, Gly, Ser, and Tyr ($P < 0.05$) while there were no differences ($P > 0.05$) between the two feeding levels for the remaining dispensable AA. Likewise, there were no differences in AID for CP or any of the AA between M2 and M3 ($P > 0.05$). The endogenous flow to the distal ileum calculated as g/kg DM intake decreased linearly ($P < 0.01$) for CP and all AA except Pro as feed intake increased from M1 to M3. Likewise, the standardized ileal digestibility coefficients (SID) for diet 1 decreased linearly ($P < 0.05$) for CP and all AA except Arg, Trp, Asp, Pro, and Tyr as feed intake increased from M1 to M3. In addition, the SID for CP and all indispensable AA except Arg, His, and Trp were lower ($P < 0.05$) at M3 than at M2. The current results demonstrate that the level of feed intake significantly influences the calculated values for AID, SID, and endogenous losses. Therefore, pigs used to measure AA digestibility coefficients and endogenous losses should be fed at a level that is close to what is used under practical conditions.

Key Words: Amino Acid Digestibility, Feed Intake, Endogenous Losses

183 Effects of lysine level fed from 10 to 20 kg on growth performance of barrows and gilts. N. A. Lenehan*[1], S. S. Dritz[1], M. D. Tokach[1], R. D. Goodband[1], J. L. Nelssen[1], and J. L. Usry[2], [1]*Kansas State University, Manhattan.*, [2]*Ajinomoto-Heartland Lysine, Chicago*.

A total of 1,440 pigs (initially 10.2 kg and 21 d after weaning) were used in a 21-d growth assay to determine the optimal lysine level to maximize growth performance of 10 to 20 kg pigs. Pigs (PIC) were blocked by gender in a completely randomized block design with 24 pigs per pen and 2 pens per experimental unit. Five levels of true ileal digestible lysine (1.1, 1.2, 1.3, 1.4 and 1.5%) were fed from d 21 to 42 after weaning. Total lysine levels were 1.24, 1.34, 1.44, 1.54, and 1.64%. All diets had the same soybean meal level with crystalline amino acids added to achieve the lysine levels while maintaining a minimum ratio of all other amino acids. Pigs were weighed and feed intake determined weekly. Both ADG and gain/feed improved linearly ($P < 0.01$) with increasing dietary lysine. The greatest response in growth performance was obtained as true digestible lysine increased to 1.4%. The results of this trial indicate that pigs weighing between 10 and 20 kg require approximately 1.4% true digestible lysine.

	True digestible lysine, %						P<	
Item	1.1	1.2	1.3	1.4	1.5	SEM	Lin.	Quad.
ADG, g	468	476	494	518	515	14	0.01	0.76
ADFI, g	706	697	704	710	710	17	0.71	0.78
Gain/feed	0.66	0.68	0.70	0.73	0.73	0.01	0.001	0.24

Key Words: Pigs, Lysine, Growth

184 Effects of feeding commercially grown gilts below or above the lysine requirement in early and late finishing on overall performance. R. G. Main, S. S. Dritz, M. D. Tokach, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan*.

Our objective was to determine the effects of feeding gilts (PIC 337 × C22) below (d 0 to 27 = 2.75 g, d 27 to 55 = 2.25 g total lysine/Mcal ME) or at (d 0 to 27 = 3.30, d 27 to 55 = 2.75 g lysine/Mcal ME) the estimated lysine:calorie ratio required for optimal performance in early finishing (32 to 77 kg). Additionally, we observed the effects of feeding gilts within each early finishing treatment below, at, or above (1.75, 2.25, 2.75 g lysine/Mcal ME, respectively) the estimated lysine requirement in late finishing (77 to 115 kg). Forty-two pens (1,154 gilts; initially 32.8 ± .8 kg) were used in a split-plot design. Diets were corn-soybean meal based with 6% choice white grease. Lysine:calorie ratios were attained by adjusting corn and soybean meal. No crystalline lysine was used. In early finishing, gilts fed at the lysine requirement had improved ($P < 0.01$) ADG (791 vs. 827 ± 7 g/d), feed efficiency (0.447 vs. 0.467 ± 0.002) and income over marginal feed cost (IOMFC; $25.65 vs. 26.55 ± 0.26/gilt). In late finishing, increasing lysine:calorie ratio improved (quadratic, $P < 0.02$) ADG (768, 834, 843 ± 9 g/day), feed efficiency (0.342, 0.370, 0.376 ± 0.003), and lean percentage (54.7, 55.7, 55.9 ± 0.12%). Gilts fed below the lysine requirement in early finishing had improved ($P < .01$) feed efficiency (0.368 vs. 0.357 ± 0.002) and feed cost per kg of gain ($0.355 vs. 0.365 ± .002) in late finishing, as compared to gilts fed adequate lysine in early finishing. Overall, gilts fed diets below requirements in early finishing, and subsequently at the estimated lysine requirement in late finishing had lower ($P < 0.03$) feed cost per kg of gain ($0.319 vs. 0.325 ± 0.002) and similar ($P > 0.70$) IOMFC ($83.46 vs. 82.97 ± 1.33), as compared to gilts fed at the estimated lysine requirement in both early and late finishing. These results suggest that as long as lysine requirements are met in late finishing for gilts, feeding slightly below the lysine requirement in early finishing decreases input cost without sacrificing overall IOMFC.

Key Words: Lysine, Finishing, Economics

185 Free and peptide-bound amino acids in small intestinal mucosa of growing pigs fed low-protein diets supplemented with amino acids. F. Guay* and N. L. Trottier, *Michigan State University, East Lansing*.

The objective of this study was to determine if reduced-protein amino acid (AA) supplemented diets alter peptide-bound (PB) and free (F) AA profiles in small intestinal mucosa of growing pigs. Twenty-four Yorkshire-Landrace growing pigs (37.0 ± 1.5 kg) were assigned to one of 4 diets in a randomized block design: 15% CP (15CP), 12CP+synthetic amino acid (SAA), 9CP+SAA and 6CP+SAA. Levels of SAA added were calculated to meet true digestible AA requirements for the growing pig. Diets were offered twice daily for 24 d. At slaughter, mucosal samples from duodenum, jejunum and ileum were collected two h post-meal. In the duodenum, free alanine was the only dispensable (D) AA to increase with reduction in dietary CP ($P < 0.05$). Reducing CP increased free lysine, methionine and threonine concentration ($P < 0.05$) but had no effect on other free indispensable (I) AA concentration. For PBAA, only lysine increased with decreased dietary CP, especially for 12 and 9CP+SAA diets ($P < 0.05$). In the jejunum, reducing CP had no effect on free DAA and IAA, except for cystine and glycine ($P < 0.05$). Lowering CP led to lower peptide-bound histidine, isoleucine, leucine, phenylalanine and valine concentration ($P < 0.05$). In the ileum, free asparagine, serine and tyrosine decreased with lowering CP ($P < 0.05$). For free IAA, reducing dietary CP decreased arginine, histidine, leucine, phenylalanine, isoleucine, tryptophan and valine concentration ($P < 0.05$). For PBAA, glycine, serine, isoleucine, leucine, lysine, phenylalanine and valine tended to decrease with decreased dietary CP ($P < 0.10$). These results show that decreasing dietary CP affected FAA and PBAA profiles in small intestinal mucosa of growing pigs. Results indicate that specific adaptation may be involved to maintain mucosal function.

Key Words: Amino Acids, Small Intestinal Mucosa, Growing Pigs

186 Influence of crystalline or protein-bound lysine on lysine utilization for growth in pigs. J. J. Colina*, P. S. Miller, A. J. Lewis, and R. L. Fischer, *University of Nebraska, Lincoln*.

Two 4-wk experiments were conducted to determine lysine utilization for growth in barrows and gilts fed individually or in groups. One hundred twelve growing pigs (56 barrows and 56 gilts; average initial BW of 18.6 kg) were used in each experiment. Pigs were fed individually or in groups of three. There were 28 pigs individually penned and 84 pigs in 28 pens (three pigs/pen). There were two replications per treatment in each experiment for a total of four replications. Dietary treatments consisted of a basal diet (0.55% lysine) and diets containing 0.65, 0.75, and 0.85% lysine that were achieved by adding lysine to the basal diet from either soybean meal (SBM) or L-lysine·HCl (crystalline). Average daily gain and ADFI were recorded. At the end of the experiments, all pigs were scanned using real-time ultrasound to determine tenth-rib backfat depth and longissimus muscle area (LMA) to calculate fat-free lean gain. Average daily gain was affected by dietary lysine concentration ($P < 0.01$), but was similar for both sources of lysine (SBM vs crystalline, respectively) at the same concentration (0.65% lysine: 524.5 vs 516.2; 0.75% lysine: 603.2 vs 616.3; 0.85% lysine: 635.2 vs 623.7 g/d). Pigs fed individually had a greater ($P < 0.05$) ADG than pigs fed in groups (586.7 vs 556.6 g). No differences among dietary treatments were observed for ADFI. However, pigs fed individually had a greater ADFI ($P < 0.05$) than pigs fed in groups (1,362 vs 1,290 g). Feed efficiency improved as the lysine concentration increased ($P < 0.01$). Backfat depth was similar among treatments. Pigs fed crystalline diets had a greater ($P < 0.05$) LMA than pigs fed SBM (15.7 vs 14.7 cm^2) at 0.85% total lysine. Gilts had a greater LMA ($P < 0.01$) than barrows (14.3 vs

13.6 cm^2). Fat-free lean gain increased ($P < 0.001$) as dietary lysine concentration increased, regardless of lysine source. Gilts had a greater ($P < 0.001$) fat-free lean gain than barrows (264.4 vs 245.2 g/d). The results suggest that lysine from SBM-bound and crystalline sources was utilized similarly for growth.

Key Words: Pigs, Lysine, Growth

187 Influence of crystalline or protein-bound lysine on body protein deposition in growing pigs. J. J. Colina*, P. S. Miller, A. J. Lewis, and R. L. Fischer, *University of Nebraska, Lincoln*.

Two 4-wk experiments were conducted to determine lysine utilization for protein deposition (PD) in barrows and gilts. Thirty-two growing pigs (16 barrows and 16 gilts; average initial BW of 18.3 kg) were used in each experiment. Pigs were randomly allotted to one of seven dietary treatments. Four pigs (two barrows and two gilts) were killed at the start and the remaining pigs were killed at the end of the experiments to determine body composition. There were two replications per treatment in each experiment for a total of four replications. Dietary treatments consisted of a basal diet (0.55% lysine) and diets containing 0.65, 0.75, and 0.85% lysine that were achieved by adding lysine to the basal diet from either soybean meal (SBM) or L-lysine·HCl (crystalline). Blood samples were taken from all pigs weekly to determine plasma urea concentration (PUC). Body protein concentration was greater ($P < 0.01$) in pigs fed the 0.75% crystalline-supplemented diet than pigs fed SBM at the same concentration (152.9 vs 160.4 g/kg). Body PD was affected by dietary lysine concentration ($P < 0.01$), but was not different between the two sources of lysine (SBM vs crystalline, respectively) at the same concentration (0.65% lysine: 77.9 vs 68.3; 0.75% lysine: 88.3 vs 96.2; 0.85% lysine: 97.3 vs 90.5 g/d). Barrows tended to have greater PD ($P = 0.08$) than gilts (88.2 vs 78.8 g/d) regardless of lysine source. Body fat concentration decreased ($P < 0.001$) as the dietary lysine concentration increased for both lysine sources at the same concentration; however, fat deposition was not affected by diet. Water deposition increased with dietary lysine concentration ($P = 0.05$). Ash variables were similar for both sources of lysine. There was a diet × week effect ($P < 0.05$) for PUC. The PUC decreased for pigs consuming crystalline-supplemented diets and increased for pigs consuming SBM-supplemented diets during the 4-week experimental period. The results suggest that PD of growing pigs fed lysine from SBM is similar to that of pigs fed crystalline lysine.

Key Words: Growing Pigs, Lysine, Protein Deposition

188 The performance of grower-finisher pigs fed diets formulated to meet amino acid requirements but with declining crude protein content. J. F. Patience[1], A. D. Beaulieu*[1], R. T. Zijlstra[1], D. A. Gillis[1], and J. Usry[2], [1]*Prairie Swine Centre, Inc., Saskatoon, SK, Canada,* [2]*Heartland Lysine, Inc., Chicago*.

A changing price structure for synthetic amino acids (AA) combined with a mounting desire to reduce nitrogen excretion is increasing interest in lower CP diets. This study examined the performance and carcass composition of grower-finisher pigs fed conventional diets or those formulated to a lower CP content. The study was divided into Phase 1 (35 to 60 kg BW), phase 2 (60 to 90 kg BW) and phase 3 (90 to 115 kg BW). Diets were pelleted and based on barley, wheat and SBM. The high CP treatment (HiCP) contained less than 0.1% L-lysine·HCl while a low CP treatment (LoCP) was formulated to meet AA requirements using maximal amounts of synthetic L-lysine·HCl, L-threonine, and DL-methionine without using L-tryptophan or other synthetic AA. A third series of diets (MedCP) was formulated to be intermediate between the HiCP and LoCP diets. Diets were formulated to contain 2.32 Mcal NE/kg (NRC, 1998). The experiment was analyzed as a factorial with 2 genders and 3 treatments using 5 pens/(trt·gender) and 22 pigs/pen (0.64 m^2/pig). Treatment did not affect ADG, ADFI, feed efficiency (gain:feed) or days to reach market weight ($P > 0.05$). Gilts gained less than barrows (0.945 vs 0.973 kg/d, $P < 0.03$), consumed less feed (2.57 vs 2.78 kg/d, $P < 0.001$) and had an improved feed efficiency ($P < 0.001$). A gender × treatment interaction for neither ADG nor ADFI was observed ($P > 0.05$). Feeding a LoCP AA supplemented diet resulted in 2 mm greater loin thickness ($P < 0.004$) relative to the HiCP diet. Treatment did not affect lean yield, fat thickness, premiums or final carcass value ($P > 0.05$). Growth performance and carcass value can be maintained while feeding low CP, AA-supplemented diets formulated on the basis of net energy.

	CP, % DM (analyzed)		**g dLys/Mcal NE** (calculated)	
	HiCP	LoCP	HiCP	LoCP
Phase 1	25.4	23.1	3.8	3.8
Phase 2				
Barrows	19.6	18.2	3.2	3.2
Gilts	21.7	19.0	3.4	3.4
Phase 3				
Barrows	17.8	15.5	2.9	2.9
Gilts	19.3	16.6	3.0	3.0

Key Words: Swine, Crude Protein, Synthetic Amino Acids

189 Influence of crystalline or protein-bound lysine on body protein deposition and lysine utilization in nursery pigs. J. J. Colina*, P. S. Miller, A. J. Lewis, and R. L. Fischer, *University of Nebraska, Lincoln*.

A 4-wk experiment was conducted to determine the efficiency of utilization for protein deposition (PD) in nursery pigs of crystalline lysine relative to the lysine in soybean meal (SBM). Pigs were 23 or 24-d-old and had an initial BW of 6 kg. Pigs were blocked by sex and weight and randomly allotted to one of five dietary treatments. Pigs were individually penned in two nursery facilities and each treatment was replicated six times. Six pigs were killed at the start and the remaining were killed at the end of the experiment to determine body composition. The dietary treatments consisted of a basal diet (1.05% lysine) and diets containing 1.15 and 1.25% lysine that were achieved by adding lysine to the basal diet from either SBM or L-lysine·HCl (crystalline). Body protein concentration was greater ($P < 0.01$) in pigs consuming the diet with 0.10% added (1.15% total lysine) crystalline lysine, than in pigs supplemented with 0.10% added lysine from SBM (159.2 vs 147.3 g/kg). However, PD was similar for both supplemented-diets with values between 80.4 and 88.8 g/d. Body fat concentration and body fat deposition were affected ($P \leq 0.07$) by diet, but were similar between the two sources of dietary lysine at the same concentration. No differences were observed among treatments for body lysine concentration or lysine deposition rate. Ash concentration was greatest ($P < 0.05$) in pigs fed 0.10% added crystalline lysine vs SBM at the same concentration (26.5 vs 24.0 g/kg). No differences were observed for body water variables among diets. The efficiency of lysine utilization for PD was greatest ($P = 0.08$) in pigs fed the basal diet and the 0.10% added crystalline lysine (50.2 and 48.5%, respectively). However, at the concentration of 1.25% lysine, the efficiency was similar between sources (44.3 vs 44.5%). The results suggest that there are no differences in the efficiency of utilization between SBM-bound lysine and lysine from L-lysine·HCl for PD in nursery pigs.

Key Words: Nursery Pigs, Lysine, Protein Deposition

190 Determining an optimum lysine:calorie ratio for 40 to 120 kg barrows 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 determine the optimum lysine:calorie ratio (g total dietary lysine/Mcal ME) for 40 to 120 kg barrows (PIC L337 × C22) in a commercial finishing environment. Three trials were conducted using randomized complete block designs (42 pens/trial, 3,281 pigs). Six treatments of increasing lysine:calorie ratio were used in each study. Diets were corn-soybean meal-based with 6% choice white grease. Lysine:calorie ratios were attained by adjusting the amount of corn and soybean meal. No crystalline lysine was used. In trial 1 (43 to 70 kg), increasing lysine:calorie ratio (2.21, 2.55, 2.89, 3.23, 3.57, and 3.91) increased (quadratic, $P < 0.01$) ADG (913, 970, 992, 966, 963, 943 ± 22 g/day), feed efficiency (0.44, 0.46, 0.47, 0.47, 0.47, 0.47 ± 0.006), income over marginal feed costs (IOMFC; $15.00, 16.11, 16.33, 15.73, 15.28, 14.83 ± 0.43/pig), feed cost per kg of gain ($0.30, 0.29, 0.29, 0.30, 0.32, 0.32 ± 0.004), and decreased (linear, $P < 0.01$) 10th rib backfat as measured by ultrasound. In trial 2 (69 to 93 kg), increasing lysine:calorie ratio (1.53, 1.78, 2.03, 2.28, 2.53, and 2.78) improved (linear, $P < 0.01$) ADG (818, 828, 893, 902, 916, 946 ± 18 g/day), feed efficiency (0.36, 0.36, 0.39, 0.38, 0.40, 0.40 ± 0.005), IOMFC ($12.06, 12.03, 13.35, 13.21, 13.63, 13.92 ± 0.35/pig), and decreased (quadratic, $P < 0.01$) backfat. In trial 3 (102 to 120 kg), increasing lysine:calorie ratio (1.40, 1.60,

1.80, 2.00, 2.20, and 2.40) improved (linear, P < 0.03) ADG (808, 818, 857, 864, 868, 877 ± 23 g/day), feed efficiency (0.31, 0.31, 0.32, 0.32, 0.33, 0.34 ± 0.005), and (quadratic, P < 0.01) lean percentage (53.9, 53.9, 53.6, 53.6, 54.2, 54.2 ± 0.15 %). Numeric improvements (linear, P = 0.12) in IOMFC ($106.64, 106.66, 106.98, 107.09, 107.60, 107.81 ± 1.40/pig) were observed as lysine increased. The equation (lysine:calorie ratio = -0.0133 × BW, kg + 3.6944) describes the lysine:calorie ratio that optimized performance and IOMFC from 40 to 120 kg.

Key Words: Lysine, Pigs, Economics

191 Determining an optimum lysine:calorie ratio for 35 to 120 kg gilts 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 determine the optimum lysine:calorie ratio (g total dietary lysine/Mcal ME) for 35 to 120 kg gilts (PIC L337 × C22) in a commercial finishing environment. Four trials were conducted using randomized complete block designs (42 pens/trial, 4,520 pigs). Six treatments of increasing lysine:calorie ratio were used in each study. Diets were corn-soybean meal-based with 6% choice white grease. Lysine:calorie ratios were attained by adjusting the amount of corn and soybean meal. No crystalline lysine was used. As in trial 1 (35 to 60 kg, reported in 2002), increasing lysine:calorie ratio (1.96, 2.24, 2.52, 2.80, 3.08, and 3.36) in trial 2 (60 to 85 kg) increased (quadratic, P< 0.02) ADG (916, 935, 960, 973, 951, 936 ± 12 g/d), feed efficiency (0.40, 0.41, 0.41, 0.43, 0.40, 0.41 ± .005), income over marginal feed costs (IOMFC; $14.42, 14.68, 14.90, 15.14, 14.13, 13.80 ± .27/hd), feed cost per kg of gain ($0.32, 0.32, 0.32, 0.33, 0.35, 0.36 ± .004), and reduced (linear, P< 0.01) backfat. In trial 3 (78 to 103 kg), increasing lysine:calorie ratio (1.53, 1.78, 2.03, 2.28, 2.53, and 2.78) improved (quadratic, P< 0.02) ADG (807, 813, 900, 917, 912, 897 ± 18 g/d), feed efficiency (0.32, 0.32, 0.35, 0.36, 0.36, 0.36 ± 0.005), IOMFC ($11.32, 11.24, 13.18, 13.41, 13.20, 12.56 ± .36), feed cost per kg of gain($.381, .388, .359, .361, .365, .382 ± .006), and reduced (linear, P< 0.01) backfat. In trial 4 (100 to 120 kg), increasing lysine:calorie ratio (1.40, 1.60, 1.80, 2.00, 2.20, and 2.40) improved (linear, P< 0.02) ADG (722, 725, 767, 837, 880, 879 ± 19 g/d), feed efficiency (0.30, 0.30, 0.33, 0.35, 0.36, 0.36 ± 0.007), IOMFC ($105.66, 106.19, 107.46, 108.87, 109.64, 109.64 ± 1.57), feed cost per kg of gain ($0.40, 0.40, 0.38, 0.36, 0.36, 0.37 ± .008), and (quadratic, P< 0.04) lean percentage (54.7, 55.1, 54.6, 55.1, 55.3, 55.5 ± .15%). The equation (lysine:calorie ratio = -0.0164 × BW, kg + 4.004) describes the lysine:calorie ratio that met biological requirements and optimized IOMFC from 35 to 120 kg.

Key Words: Lysine, Pigs, Economics

192 Evaluation of the lysine requirements for barrows fed ractopamine HCl (Paylean®) under conditions of heat stress. D. C. Kendall*, J. W. Frank, A. M. Gaines, G. F. Yi, and G. L. Allee, *University of Missouri, Columbia*.

Two experiments were conducted to evaluate the lysine requirement of barrows fed ractopamine HCl (Paylean®, RAC) under heat-stress conditions. Exp. 1 was conducted in the Brody environmental chambers at the University of Missouri. Seventy-two barrows (TR-4 x PIC C-22) were subjected to a controlled cycling heat stress (cycling from 27 C at 2400 h to 35 C maintained from 1100 to 1900 h; HS) and fed corn-soy meal diets containing 10 ppm RAC and 3.51 Mcal ME/kg. Pigs were fed one of three dietary Lys levels (0.70, 0.95, or 1.20% total Lys) for 20 days to 6 replicate pens of 3 pigs/pen. An additional treatment consisted of pigs housed at thermoneutral conditions (21 C; TN) and fed a diet containing 10 ppm RAC and 1.20% total Lys. There was a linear improvement in ADG (P < 0.05) and feed efficiency (P < 0.05) with increasing Lys level (593, 633, and 782 g/d, respectively; 0.178, 0.218, and 0.255, respectively). Pigs fed the 1.20% total Lys diet in the TN environment had higher ADG (P < 0.01), ADFI (P < 0.01) and tended to be more efficient (0.371 vs 0.340, P < 0.07) than pigs fed 1.20% total Lys in HS. In Exp. 2, 210 barrows (TR-4 x PIC C-22) were housed in a cycling heat stress environment (28 to 34 C) and fed corn-soy meal diets containing 10 ppm RAC and 3.47 Mcal ME/kg. Pigs were fed one of four dietary Lys levels (0.90, 1.10, 1.30, or 1.50% total Lys) for 25 d to 6 replicate pens of 7 pigs/pen. A fifth treatment consisted of the 0.90% total Lys diet without RAC. There were no differences in ADG or loin eye area accretion among the RAC fed treatments; however, ADFI (P < 0.01) and tenth rib backfat accretion (P < 0.05) decreased linearly with increasing Lys level. Therefore, feed efficiency linearly (P < 0.01) and quadratically (P < 0.05) improved with increasing Lys level (0.399, 0.414, 0.441, and 0.421, respectively). Pigs fed diets with 10 ppm RAC and 0.90% total Lys had greater ADG (P < 0.02), feed efficiency (P < 0.001), and loin eye area accretion (P < 0.03) than non-RAC fed pigs. These experiments demonstrate that feeding Paylean® improves the growth performance of heat-stressed pigs and that the lysine requirement of barrows fed Paylean® may be as high as 1.30% total lysine under heat-stress conditions.

Key Words: Pigs, Ractopamine, Lysine

193 The effects of environmental housing conditions on two ractopamine use programs in finishing pigs. S. A. Trapp*, B. E. Hill, S. L. Hankins, A. P. Schinckel, and B. T. Richert, *Purdue University, West Lafayette, IN*.

Littermate barrows (93) and gilts (96) were used in a 6-wk study evaluating the effect of environmental housing conditions on two ractopamine use programs for late finishing pigs. All pigs were weaned into an SEW nursery. Following the nursery period, they were sorted into two environments: an all-in-all-out grow/finish facility with high bio-security measures in place (AIAO) or into a continuous flow system for the grow/finish phase (CF). At an average initial BW = 72.1 kg, pigs were allotted by weight, sex and ancestry to one of three ractopamine (RAC) treatments (trt): 1) control, no RAC; 2) 5 ppm RAC wks 0-3, 10 ppm RAC wks 4-6; 3) 10 ppm RAC wks 0-6. Barrows were fed a 1.05% Lys diet wks 0-3 and a 1.00% Lys diet wks 4-6; gilts were fed a 1.15% Lys diet wks 0-3 and a 1.10% Lys diet wks 4-6. Pigs fed RAC had increased ADG (1022 vs 867 g/d; P < 0.05) and increased G:F (0.416 vs 0.359; P < 0.05) compared to the control trt during wk 0-3. Overall, pigs fed RAC had increased ADG (958 vs 872 g/d, P < 0.05) and increased G:F (0.378 vs 0.338, P < 0.05) compared to the control trt. Additionally, pigs fed trt 2 had greater ADG (990 vs 926 g/d, P < 0.05) than trt 3 during wk 0-6. Pigs fed trt 2 also had increased final BW (109.0, 114.0, 110.8 kg; trt 1-3 respectively, P < 0.05) than the control trt. Real-time ultrasound data indicate that pigs fed RAC had increased loin eye area (LEA) (42.8, 45.8, 46.0 cm^2; trt 1-3 respectively, P < 0.05) and decreased 10^{th} rib backfat (20.4, 18.5, 18.4 mm; trt 1-3 respectively, P < 0.05). No significant differences between housing systems or interactions between grow/finish environments and treatments were found for overall ADG, ADFI, G:F, or carcass characteristics (P > 0.05). However, pigs in the CF environment were 11 d older at the start of the experimental BW. Both RAC use programs had increased pig growth rate and feed efficiency with nearly identical LEA and backfat depths over the control. Additionally, the step-up RAC trt had greater final BW and ADG than the constant RAC trt, while utilizing less RAC in the late finishing period.

Key Words: Ractopamine, Pigs, Environment

194 Interactive effects between dietary L-carnitine and ractopamine HCl (Paylean®) on finishing pig growth performance. B. W. James*[1], M. D. Tokach[1], R. D. Goodband[1], J. L. Nelssen[1], S. S. Dritz[1], K. Q. Owen[2], and J. C. Woodworth[2], [1]*Kansas State University, Manhattan,* [2]*Lonza, Inc., Fair Lawn, NJ*.

A total of 2,152 pigs were used in four experiments to determine the interactive effects of dietary carnitine and ractopamine HCl (Paylean®, RAC). All trials were arranged as factorials with main effects of carnitine (0, 25, or 50 ppm in Exp. 1 and 2 and 0 or 50 ppm in Exp. 3 and 4) and RAC (0, 5, or 10 ppm in Exp. 1 and 0 or 10 ppm in Exp. 2, 3, and 4). Dietary carnitine was fed from 38 kg to market (Exp. 1 and 3) or for the last 3 or 4 wk before market (Exp. 4 and 2, respectively). Ractopamine was fed prior to market for 4 wk in Exp. 1, 2, and 3, and 3 wk in Exp. 4. Experiments 1 and 2 were conducted in university research facilities and Exp. 3 and 4 in commercial research barns. All diets were formulated to 1.0% Lys during the last phase of each experiment. In all experiments, pigs fed RAC had increased (P < 0.05) ADG and feed efficiency (G:F) compared to pigs not fed RAC. Feeding carnitine prior to the RAC feeding period did not affect (P > 0.25) pig performance. In Exp. 1 and 2, carnitine did not affect (P > 0.46) ADG during the 4 wk prior to market; however, G:F tended (quadratic; P < 0.07) to improve with increasing carnitine in Exp. 2. In Exp. 3, a carnitine × RAC interaction was observed (P < 0.04) for ADG and G:F. Both carnitine and RAC improved performance, but not additively. In Exp. 4, pigs fed carnitine had increased (P < 0.04) ADG (0.88 vs 0.84 kg) and G:F

(0.36 vs 0.35) compared to pigs not fed carnitine and the response was additive to that of RAC. In analysis of the treatments common to all experiments, pigs fed diets containing RAC had increased ($P < 0.01$) ADG (1.03 vs 0.93 kg) and G:F (0.40 vs 0.35) compared to pigs not fed RAC. Carnitine tended to increase ($P < 0.07$) ADG (1.00 vs 0.96 kg) and improved ($P < 0.01$) G:F (0.38 vs 0.37) compared to pigs not fed carnitine. These results suggest that carnitine and RAC improve growth performance of finishing pigs with the greatest response to carnitine occurring in commercial environments.

Key Words: Carnitine, Ractopamine, Pigs

195 Interactive effects of dietary L-carnitine and ractopamine HCl (Paylean®) on finishing pig carcass characteristics and meat quality. B. W. James*[1], M. D. Tokach[1], R. D. Goodband1[1], J. L. Nelssen[1], S. S. Dritz[1], K. Q. Owen[2], and J. C. Woodworth[2], [1]*Kansas State University, Manhattan,* [2]*Lonza, Inc., Fair Lawn, NJ.*

Three experiments utilizing 1,356 pigs were conducted to determine the interactive effects of dietary carnitine and ractopamine HCl (Paylean®, RAC) on carcass and meat quality. Experiments were arranged as factorials with main effects of carnitine and RAC. Carnitine levels were 0, 25, or 50 ppm in Exp. 1 and 2 and 0 or 50 ppm in Exp. 3. Ractopamine levels were 0, 5, or 10 ppm in Exp. 1 and 0 or 10 ppm in Exp. 2, and 3. Dietary carnitine was fed from 38 kg to market (Exp. 1 and 3) or for 4 wk before market (Exp. 2). Ractopamine was fed for 4 wk. Experiments 1 and 2 were conducted at university research facilities and Exp. 3 in a commercial research barn. A carnitine × RAC interaction ($P < 0.02$) was observed for visual color, L*, and a*/b* in Exp. 1. In pigs fed RAC, increasing carnitine decreased L* and increased visual color scores and a*/b* compared to pigs not fed RAC. Ultimate pH tended to increase (linear, $P < 0.07$) with increasing carnitine. Drip loss decreased (linear, $P < 0.04$) in pigs fed increasing carnitine. In Exp. 2, a carnitine × RAC interaction was observed ($P < 0.04$) for visual firmness and drip loss. Visual firmness scores decreased in pigs fed increasing carnitine and no RAC, but increased with increasing carnitine when RAC was added to the diet. Drip loss decreased with increasing levels of carnitine when fed with RAC. Percentage lean was higher ($P < 0.01$) for pigs fed RAC. A carnitine × RAC interaction ($P < 0.03$) was observed in Exp. 3 for fat thickness and percentage lean. Fat thickness decreased and lean percentage increased in pigs fed carnitine or RAC, but the responses were not additive. Pigs fed carnitine tended ($P < 0.06$) to have decreased drip loss. Pigs fed RAC had decreased ($P < 0.05$) 10th rib and average backfat and decreased drip loss compared to pigs not fed RAC. These results suggest that ractopamine increases carcass leanness and supplemental carnitine reduces drip loss when fed in combination with ractopamine.

Key Words: Carnitine, Ractopamine, Pigs

196 Effects of fish oil on growth performance, immune, adrenal and somatotrophic responses of weanling pigs after lipopolysaccharide challenge. Y. L. Liu[1], D. F. Li*[1], L. M. Gong[1], G. F. Yi[2], and A. M. Gaines[2], [1]*China Agricultural University, Beijing,* [2]*University of Missouri, Columbia.*

Seventy-two crossbred pigs weaned at 28 d of age were used to investigate the effects of fish oil on growth performance, immune, adrenal, and somatotrophic responses following E. coli lipopolysaccharide (LPS) challenge in a 2 × 2 factorial arrangement of treatments. The main factors consisted of oil type (7% corn oil or fish oil) and immune challenge (LPS or saline). Pigs were randomly assigned to treatments. On d 14 and 21 postweaning, pigs were i.p. injected with either 200 μg/kg BW of LPS or an equivalent amount of sterile saline. At 3 h postinjection, blood plasma samples were collected for analysis of IL-1β, cortisol (CS), GH, and IGF-I. On d 2 after LPS challenge, blood samples were collected for lymphocyte proliferation and antibody responses to Albumin Bovine V Boehringer (BSA). The performance parameters of ADG, ADFI, and G:F were also evaluated during the 28 d experiment. Our results indicated that LPS-challenge depressed ADG ($P \leq 0.05$) from d 14-28 and ADFI ($P \leq 0.05$) from d 14-21. On both d 14 and 21, plasma IL-1β ($P \leq 0.01$), CS ($P \leq 0.001$), and blood lymphocyte proliferation ($P \leq 0.05$) were increased, whereas IGF-1 ($P \leq 0.01$) was decreased after LPS-challenge. LPS-challenge also resulted in decreased plasma GH ($P \leq 0.05$) on d 14. Neither LPS-challenge or oil type affected serum antibody response to BSA ($P \geq 0.10$). Fish oil did improve ADG and ADFI during the first LPS-challenge period (d 14-21; $P \leq 0.10$). No LPS-challenge × oil type interactions were observed for any of the growth performance parameters during the 28 d period ($P \geq 0.10$). Fish oil decreased blood lymphocyte proliferation incubated with 16 μg/mL concanavalin A during the first challenge period ($P \leq 0.10$); however, no LPS-challenge × oil interaction was observed ($P \geq 0.10$). On both d 14 and 21, feeding fish oil decreased plasma CS ($P \leq 0.05$) and plasma IL-1β ($P \leq 0.10$) in LPS-challenged pigs. Pigs fed fish oil also had higher plasma IGF-1 ($P \leq 0.10$) as compared to pigs fed the corn oil diet on both d 14 and 21. No LPS-challenge × oil interaction was observed for plasma GH ($P \geq 0.10$). These data suggest that fish oil alters indices of the immune axis that may lead to improved growth performance during an inflammatory challenge.

Key Words: Pigs, Fish Oil, Lipopolysaccharide

197 Evaluation of a botanical extract in nonmedicated diets for pigs 15 to 113 kg body weight. B. V. Lawrence*[1], J. D. Hahn[1], S. Hansen[1], J. Hedges[1], E. Hansen[1], R. Musser[1], and J. Corley[2], [1]*Hubbard Feeds Inc., Mankato, MN,* [2]*Prince Agri Products, Inc., Quincy IL.*

A botanical extract (Xtract) addition to antibiotic free diets was evaluated in 3 trials. In Exp. 1, 549 pigs (15.1 ± 0.82 kg) were allotted to 1 of 3 treatments (n = 8), either non-medicated diet (Non-Med), Non-Med + 182 g/t Xtract, or medicated with Tylan at 44 g/t (Med). During the 21-d trial, ADG tended to be lower ($P < 0.10$) for the Non-Med (571 g/d) compared with Xtract (610 g/d) and Med (615 g/d) pigs. Intake was similar ($P > 0.10$) across treatments (927 ± 59.9 g/d) resulting in an improvement in gain/feed ($P < 0.01$) for the Xtract (0.65) compared with Non-Med (0.62) treatments. Gain/feed was highest ($P < 0.05$) for the Med (0.68) treatment. In Exp. 2, 254 pigs (30.2 ± 1.46 kg) were used to evaluate Xtract vs. Non-Med in a 91-d trial (n = 6). No treatment differences were detected ($P > 0.10$). Pigs had an ADG of 914 ± 41.8 g/d with a gain/feed of 0.39 ± 0.03. In Exp. 3, 351 pigs (24.3 ± 0.76 kg) were allotted to Non-Med, Xtract, or Med treatments (n = 6) in a 100-d trial. In Exp. 3, the Med group consisted of a rotation of 660 g/t chlortetracyline for 7 d followed by 44 g/t of Tylan for 21 d. Cumulative ADG (885 ± 29.6 g/d) and gain/feed (0.39 ± 0.02) were not different ($P > 0.10$) across treatments. However, during period 3 (day 43 to 64) an undiagnosed digestive disturbance occurred. During this period, gain/feed was improved ($P < 0.05$) for the Xtract (0.42) and Med (0.42) treatments compared with Non-Med (0.38). The improvement in gain/feed was the result of a numerical improvement ($P > 0.20$) in ADG (889 vs 928 and 942 g/d) and numerical decrease ($P > 0.31$) in intake (2.38 vs 2.25 kg/d). Results of these experiments suggest that during periods of disease challenge, Xtract may improve ADG and gain/feed compared with Non-Med pigs. This improvement may be intermediate to, or equal to that observed with in-feed antibiotics. When no disease challenge is present, pig performance may not be improved by either Xtract or the antibiotic programs evaluated in these trials.

Key Words: Botanical Extract, Pigs, Antibiotics

198 Effect of milk supplementation with *Lactobacillus brevis* 1E-1 on intestinal microflora, intestinal morphology, and pig performance. D. C. Brown*[1], M. E. Davis[1], C. V. Maxwell[1], Z. B. Johnson[1], T. Rehberger[2], K. J. Touchette[3], and J. A. Coalson[3], [1]*University of Arkansas, Fayetteville,* [2]*Agtech Products, Inc., Waukesha, WI,* [3]*Merrick's, Inc., Union Center, WI.*

Two experiments were conducted to determine the effect of milk supplementation with *Lactobacillus brevis* 1E-1 on pig performance, intestinal microflora, and gut morphology. Litters were allotted to two treatments at farrowing: 1) control milk supplement, and 2) as 1 with 1E-1. At weaning, pigs from the two lightest blocks were offered the control treatment for 5 d. One pig/litter was sacrificed at 10, 22 (weaning), and 28 d of age to assess gut morphology and intestinal microflora populations. In Exp. 1, pigs fed 1E-1 had a greater ADG ($P \leq 0.05$) compared to the control in the first 5 d postweaning. Small pigs provided milk supplement also had increased ADG ($P \leq 0.05$) in the first 5 d postweaning compared to normal-sized pigs. Gain:feed was greater ($P \leq 0.05$) from d 0 to 14 after weaning when small pigs were previously fed 1E-1 compared to control pigs, while previous supplementation did not affect performance of normal-sized pigs (interaction, $P \leq 0.05$). Data previously reported from this experiment indicated that 1E-1 decreases *E. coli* populations in the jejunum pre-weaning and at weaning

compared to control pigs. In Exp. 2, 1E-1 addition did not affect pig performance. Similar to Exp. 1, 1E-1 decrease coliform populations in the jejunum ($P = 0.07$) and ileum ($P \leq 0.01$) at weaning; however, populations in control pigs were about 2 logs lower than in Exp. 1. Pigs provided 1E-1 had greater ($P \leq 0.01$) ileal villus:crypt ratio at 10 d of age compared to control pigs, although there was no difference at 21 and 28 d of age (interaction, $P \leq 0.05$). The number of duodenal sulfuric goblet cells was less ($P = 0.06$) when pigs were provided 1E-1 compared to control pigs at 10 d of age, although there was no difference at 21 and 28 d of age (interaction, $P = 0.06$). These data indicate that milk supplementation with 1E-1 during lactation improves subsequent nursery performance and may provide a healthier intestinal environment.

Key Words: Swine, Milk Substitutes, Lactobacillus

199 Evaluation of BioPlus 2B in non-medicated diets for pigs from 15 to 113 kg body weight. B. V. Lawrence*, J. D. Hahn, S. Hansen, J. Hedges, E. Hansen, and R. Musser, *Hubbard Feeds Inc., Mankato, MN*.

Two experiments were conducted to evaluate *Bacillus* spp. from BioPlus 2B in corn-soybean meal antibiotic-free diets. In Exp. 1, 935 terminal Duroc pigs (Compart Boar Store Line 442 X D100) weighing 14.5 ± 0.87 kg were allotted to 1 of 5 dietary treatments. Diets were either non-medicated (Non-Med), medicated with Tylan at 44 g/t (Med), or supplemented with 1 X 10^6 cfu/g of *Bacillus* spp. with 0, 2.5, or 5% lactose (n = 8). Pigs were housed in 2.44 X 2.44 m pens with 23 or 24 pigs/pen. During the 21-d trial, no treatment differences ($P > 0.10$) were detected. Pigs gained 553 ± 37.8 g/d, consumed 872 ± 47.7 g/d with a gain/feed of 0.63 ± 0.01. In Exp. 2, 256 terminal Duroc pigs (Compart Boar Store Line 442 X D100) weighing 29.9 ± 1.58 kg were used in a 91-d trial to evaluate the influence of the addition of 1 X 10^6 cfu/g of *Bacillus* spp. to a Non-Med diet on gain, intake, and gain/feed (n = 6). Pigs were housed in 2.74 X 5.48 m pens with 21 or 22 pigs per pen. Pigs were weighed on days 0, 22, 43, 63, 77 and 91. Gain, intake and gain/feed were calculated for each time period. No differences ($P > 0.10$) in dietary treatments were detected during any growth period. Cumulative gain averaged 912 ± 27.4 g/d with an intake of 2.33 ± 0.14 kg/d resulting in a gain/feed of 0.39 ± 0.02. During the 21-d nursery trial, no response was observed to either Tylan or *Bacillus* spp., thus suggesting a low digestive disease presence in the pigs used in this experiment. These results, therefore, indicate that during a low disease challenge from 15 to 27 kg BW, no growth promoting effect can be anticipated from either Tylan at 44 g/t or 1 X 10^6 cfu/g of *Bacillus* spp.from BioPlus 2B. The results of Exp. 2 suggest that during periods of low disease challenge in the growing-finishing period, *Bacillus* spp. in BioPlus 2B may not provide any improvement in either gain or gain/feed.

Key Words: *Bacillus* spp, Pigs, Antibiotics

200 Corn particle size and pelleting influence on fecal shedding and enteric colonization of Salmonella enterica serotype Typhimurium. M. R. Barker*, S. S. Dritz, J. C. Nietfeld, J. E. Minton, J. M. DeRouchey, K. M. Bond, D. J. Lee, and T. E. Burkey, *Kansas State University, Manhattan*.

Evidence indicates that diets fed in pellet form are associated with a higher prevalence of Salmonella shedding and is hypothesized to affect the colonic microenvironment in a way that is conducive to Salmonella growth. Since the grain used in pelleted diets is usually finely ground, our objective was to evaluate the interactive effects between diet form and grain particle size on Salmonella entericia serotype Typhimurium (ST) shedding and colonization in a young growing pig model. A total of 96 weaned pigs (6.3 kg BW) were blocked by weight in a randomized complete block design with a 2 × 2 factorial treatment arrangement of treatments. The main effects were corn particle size (500 or 1000 microns) and diet form (pellet or meal) using the same diet formulation. There were 12 pens/treatment and two pigs/pen. Pigs were fed the diets 7 d before oral inoculation with 1.9×10^7 CFU of ST. Fecal samples were cultured on d 7, 14, and 21, and mesenteric lymph nodes on d 21 after inoculation to categorize relative presence of ST using semi-quantitative methods. Cultures were scored 0 (no ST detected) to 3 (most abundant ST). Body weight and feed intake were measured to calculate ADG, ADFI, and feed efficiency (G/F). As expected, pigs fed the 500 micron corn had better G/F ($P < 0.02$) than pigs fed 1000 micron corn. Unexpectedly, the pigs fed meal feed had better G/F ($P < 0.01$) than pigs fed diets in pellet form. This was the result of meal fed pigs having better growth rate with slightly higher feed intake. There was no evidence ($P > 0.22$) of differences in fecal shedding score (1.0, 1.0, 0.9, 0.7 0.2 for pigs fed diets with 500 micron meal or pellet or 1,000 micron meal or pellet, respectively) or mesenteric lymph node culture score (0.4, 0.5, 0.5, 0.5 0.2, respectively). Using this model, we were unable to detect influences of feed processing on fecal shedding or colonization of mesenteric lymph nodes with Salmonella entericia serotype Typhimurium.

Key Words: Weanling Pigs, Salmonella, Particle Size

201 Evaluation of BioSaf and Safmannan in non-medicated diets for pigs 15 to 113 kg body weight. B. V. Lawrence*, J. D. Hahn, S. Hansen, J. Hedges, E. Hansen, and R. Musser, *Hubbard Feeds Inc., Mankato, MN*.

Two experiments were conducted to evaluate *Saccaromyces cerevisiae* as BioSaf yeast and Safmannan, a mannanoligosacharide from *Saccaromyces cerevisia*, in corn-soy antibiotic-free diets. In Exp. 1, 732 terminal Duroc pigs (Compart Boar Store Line 442 X D100) weighing 15.2 ± 0.68 kg were allotted to 1 of 4 dietary treatments. Diets were either non-medicated diet (Non-Med), medicated with Tylan at 44 g/t (Med), supplemented with 5 X 10^6 cfu/g of *Saccaromyces cerevisiae* (BioSaf), or 0.10% Safmannan (n = 8). During the 21-d trial, ADG was lower ($P < 0.01$) for the Non-Med pigs (571 g/d) than for the Med (615 g/d), BioSaf (622 g/d) and Safmannan (631 g/d) treatments. Growth rate of the Med, BioSaf, and Safmannan treatments were similar ($P > 0.10$). Intake was not different across treatments (934 ± 51.1 g/d). Gain/feed was lowest for the Non-Med group (0.62) and was improved ($P < 0.001$) for the Med, BioSaf, and Safmannan treatments. The Med pigs had the highest gain/feed (0.68), with 0.10% Safmannan resulting in a gain/feed similar to that observed for the Med pigs (0.66). The pigs fed diets containing BioSaf gain/feed (0.65) which was greater ($P < 0.05$) than that observed for the pigs fed Non-Med diets, but less ($P < 0.05$) than that observed for the pigs fed the Med diets. In Exp. 2, 256 terminal Duroc pigs (Compart Boar Store Line 442 X D100) weighing 29.8 ± 1.16 kg were fed either a Non-Med or BioSaf diet (n = 6) During the 91-d trial pigs were weighed on d 0, 22, 43, 63, 77 and 91. Gain, intake, and gain/feed were calculated for each growth period. No treatment differences were detected ($P > 0.10$). Cumulative ADG was 919 ± 24.9 g/d with an intake of 2.31 ± 0.15 kg/d resulting in a gain/feed of 0.39 ± 0.02. The results of these experiments suggest that during periods of disease challenge from 15 to 28 kg BW, both BioSaf and Safmannan may result in an improvement in ADG and gain/feed. Additionally, results of Exp. 2 indicate that from 30 t 113 kg BW, BioSaf may not result in an improvement in pig performance in the absence of disease challenge.

Key Words: Yeast, Pigs, Antibiotics

202 Effect of altered dietary n6/n3 fatty acid ratios and endotoxin injection on performance and immune parameters in nursery pigs. T. A. Meyer*, M. D. Lindemann, K. K. Schillo, and G. L. Cromwell, *University of Kentucky, Lexington*.

A total of 72 weanling pigs (23 d of age, 7.6 kg) were used in two 5-wk trials to evaluate if performance and immune function of pigs fed varied dietary n6/n3 fatty acid ratios (n6/n3) are altered in response to lipopolysaccharide endotoxin (LPS [50 g/kg BW]). Diets contained 1.22% lysine, and other nutrients met or exceeded NRC (1998) requirement estimates. Three diets contained 5% menhaden and(or) corn oil with resultant n6/n3 of 1.2, 6.8, and 34.8. Pigs were blocked by weight and age and randomly allotted to pens (two/pen) and diet. Each pen of pigs received either an LPS or saline i.p. injection after 4 wk. Pig weights and feed intake were recorded weekly for 4 wk, and every 6, 12, and 24 h post-injection. Blood was collected at 0, 2, and 4 h post-injection to analyze serum TNF-α and cortisol levels. Rectal temperatures were recorded at 0 h, every 2 h post-injection for 12 h, and at 24 h. The treatment means for overall 4-wk or Wk 5 ADG and F/G (0.61 and 0.68 kg; 1.46 and 1.97, respectively) did not differ ($P \geq 0.06$) among treatments. ADFI (0.82, 0.90, 0.92 kg) increased (linear, $P \leq 0.05$) for the overall 4-wk period with increasing n6/n3. A Wk 5 saline vs LPS effect ($P \leq 0.01$) occurred for ADG and F/G (0.85 vs 0.52 kg; 1.79 vs 2.15). A Wk 5 diet by injection interaction ($P \leq 0.05$) occurred in ADFI for saline (1.56, 1.49, 1.51 kg) and LPS (0.99, 1.16, 1.11 kg) pigs fed increasing n6/n3. The 2-h serum TNF-α (5.8, 5.2, 3.3 ng/ml) decreased (linear, $P \leq 0.05$) with increasing n6/n3. The serum cortisol difference

at 4-h post-injection increased (linear, $P \leq 0.05$) with increasing n6/n3 (4.1, 5.1, 7.7 μg/dl) and by LPS vs saline (13.9 vs -2.6 μg/dl). Body temperature increased (linear, $P \leq 0.01$) with increasing n6/n3 with the LPS (39.5, 39.8, 39.9°C) but not the saline (39.6, 39.6, 39.7°C) injections, with differences ($P \leq 0.05$) between injections at the higher two n6/n3 diets. Dietary n6/n3 did not affect ADG ADFI, F/G or immune parameters in response to an immune challenge.

Key Words: Pigs, Fatty Acids, Endotoxin

203 Responsiveness of weanling pigs to Carbadox (Mecadox®) and vitamin B_{12} supplementation. S. S. Blodgett*, P. S. Miller, and R. L. Fischer, *University of Nebraska, Lincoln.*

An experiment was conducted to assess the responsiveness of weanling pigs (96 barrows and gilts) to supplemental antibiotics (Carbadox) and vitamin B_{12}. Pigs (initial weight 5.13 kg) were fed one of four diets for a total of 35 days: 1) negative control, common nursery diet with no added Carbadox or vitamin B_{12}; 2) antibiotic, common nursery diet with 55 ppm added Carbadox; 3) vitamin B_{12}, common nursery diet with 80 μg/kg added vitamin B_{12}; and 4) positive control, common nursery diet with 55 ppm added Carbadox and 80 μg/kg added vitamin B_{12}. The study was conducted as a 2 × 2 factorial with 4 replications (pens; 6 pigs/pen) per treatment. Pig weights and feed disappearance were measured weekly to determine ADG, ADFI, and feed efficiency (ADG/ADFI). Pigs were visually scored to assess any potential vitamin B_{12} deficiencies on d 14, 21, 28, and 35. No Carbadox × vitamin B_{12} interactions were observed ($P > 0.10$). During Phase I (d 0 to 14), pigs fed Carbadox had a greater ADG (223.5 vs 195.6 g, $P < 0.02$) and ADFI ($P < 0.003$) versus pigs not fed supplemental antibiotics. During Phase II and the overall experimental period, pigs fed vitamin B_{12} had greater ADG (558.1 vs 505 g and 418.6 g vs. 386.9 g, respectively; $P < 0.003$), ADFI ($P < 0.04$), and improved feed efficiency ($P < 0.006$ and $P < 0.03$, respectively) compared to pigs not fed supplemental vitamin B_{12}. During Phase II (d 15 to 35), pigs fed Carbadox had greater ADFI ($P < 0.02$) versus pigs not fed Carbadox. For the overall experimental period, pigs fed Carbadox had greater ADG (414 vs 391.9 g; $P < 0.02$) and ADFI ($P < 0.004$) versus pigs not fed Carbadox. During Phase II and overall, pigs supplemented with Carbadox had lower ADG/ADFI ($P < 0.02$ and $P < 0.04$, respectively). There were no differences among groups for visual assessment of B-vitamin deficiencies. Pigs responded to vitamin B_{12} in the absence of antibiotic in the diet. The results from this study indicate that the vitamin B_{12} requirement of 10- to 20-kg pigs may be greater than the current NRC requirement recommendation.

Key Words: Nursery Pigs, Antibiotic, Vitamin B_{12}

204 Vitamin B_{12} requirement of weanling pigs. S. S. Blodgett*, P. S. Miller, and R. L. Fischer, *University of Nebraska-Lincoln.*

An experiment was conducted to help define the vitamin B_{12} requirement of the 5- to 20-kg pig. A total of one hundred and fourty-four pigs(barrows and gilts; initial weight = 5.08 kg) were fed one of six diets (4 pigs/pen; 6 reps/treatment) for a total of 35 days: 1) negative control, common nursery diet with no added vitamin B_{12}; 2) 1X, addition of 100% the 1998 NRC-requirement for a 5- to 10-kg pig for vitamin B_{12} (17.5 μg/kg of diet), 3) 2X, addition of 200% the 1998 NRC-requirement for a 5- to 10-kg pig for vitamin B_{12} (35 μg/kg of diet), 4) 4X, addition of 400% the 1998 NRC-requirement for a 5- to 10-kg pig for vitamin B_{12} (70 μg/kg of diet), 5) 8X, addition of 800% the 1998 NRC-requirement for a 5- to 10-kg pig for vitamin B_{12} (140 μg/kg of diet), 6) 16X, addition of 1,600% the 1998 NRC-requirement for a 5- to 10-kg pig for vitamin B_{12} (280 μg/kg of diet). Pig weights and feed disappearance were measured weekly to determine ADG, ADFI, and feed efficiency (ADG/ADFI). Pigs were visually scored to assess any potential vitamin B_{12} deficiencies on d 14, 21, 28, and 35. During Phase I (d 0 to 14), there were no growth or feed intake responses to supplemental vitamin B_{12}. During Phase II (d 15 to 35), ADG and ADG/ADFI responded quadratically to vitamin B_{12} supplementation ($P < 0.007$ and $P < 0.02$, respectively). Pigs fed 8X the NRC requirement for the 5- to 10-kg pig had the greatest ADG (609 g) and pigs fed 4X the NRC requirement had the greatest ADG/ADFI (0.721 g/g). For the overall experimental period, there was a trend for a linear growth response ($P < 0.07$). Pigs fed 8X the NRC requirement had the greatest ADG (477 g). Also, there was a quadratic ADG/ADFI response ($P < 0.02$). Pigs supplemented with 4X the NRC requirement had the greatest ADG/ADFI (0.718 g/g). Feed intake did not respond to vitamin B_{12} supplementation. Based on these results, the vitamin B_{12} requirement of the 5- to 10-kg pig is similar to that recommended by the 1998 NRC (17.5 μg/kg). The 10- to 20-kg pig responded to vitamin B_{12} supplementation between 4.5 and 9 times the dietary concentration that is currently recommended by the 1998 NRC (15 μg/kg of diet).

Key Words: Nursery, Pigs, Vitamin B_{12}

205 Effects of different wheat gluten sources on nursery pig growth performance. K. R. Lawrence*, R. D. Goodband, M. D. Tokach, S. S. Dritz, J. L. Nelssen, J. M. DeRouchey, C. W. Hastad, S. H. Hanni, M. R. Barker, and B. W. James, *Kansas State University, Manhattan.*

Four experiments were conducted to determine the effects of different wheat gluten (WG) sources compared to soybean meal (SBM) or spray-dried animal plasma (SDAP) on growth performance of nursery pigs. In Exp. 1, 220 pigs (6.1 kg BW; 8 pens/trt; 6 pigs/pen) were fed a control diet containing 6% of either SDAP, enzymatically hydrolyzed WG, or non-hydrolyzed WG. The WG and L-lysine HCl replaced 50% or 100% of the SDAP. From d 0 to 21, increasing WG (either source) decreased ADG and ADFI (linear, $P < 0.01$), but improved G/F (linear, $P < 0.04$). In Exp. 2, 252 pigs (6.2 kg BW; 6 pens/trt; 6 pigs/pen) were fed a negative control containing no SDAP or WG, 9% WG, 6.75% WG & 1.25% SDAP, 4.5% WG & 2.5% SDAP, 2.25% WG & 3.75% SDAP, or a positive control containing 5% SDAP. From d 0 to 14, pigs fed increasing WG had decreased ADG (linear, $P < 0.05$) and ADFI (linear, $P < 0.10$). In Exp. 3, 240 pigs (7.0 kg BW; 7 pens/trt; 5 pigs/pen) were fed a negative control diet containing no WG or SDAP, the control diet containing either 3, 6, 9, or 12% spray-dried WG, or a positive control diet containing 5% SDAP. The diets containing 9% WG and 5% SDAP had the same amount of SBM. From d 0 to 7, pigs fed 5% SDAP had greater ($P > 0.05$) ADG than pigs fed the diet containing 9% WG. Overall (d 0 to 14), increasing WG had no effect ($P > 0.05$) on ADG, ADFI, or G/F. In Exp. 4, 200 pigs (6.0 kg BW; 8 pens/trt; 5 pigs/pen) were fed a negative control diet, which contained no SDAP or WG, the control diet with 4.5% or 9.0% enzymatically hydrolyzed WG, or the control diet with 2.5% or 5.0% SDAP. Diets containing WG and SDAP had similar SBM levels. From d 0 to 14, increasing SDAP improved (linear, $P < 0.06$) ADG, but increasing WG had no effect. There were no differences ($P > 0.05$) in ADG, ADFI, or G/F between the wheat gluten sources used in these trials. The results of these studies suggest that increasing WG in diets fed immediately after weaning did not improve growth performance.

Key Words: Pigs, Wheat Gluten, Spray-dried Animal Plasma

206 An evaluation of barley, corn or wheat-based diets, with and without glucanase and xylanase addition, on the nitrogen balance and ammonia emission of finishing boars. A.B.G. Leek*[1], V. E. Beattie[2], W. Henry[2], and J. V. O'Doherty[1], [1]*University College Dublin, Ireland,* [2]*Devenish Nutrition Ltd., Belfast, Northern Ireland.*

Finishing boars (67 kg) were used in a 3 x 2 factorial arrangement of treatments to investigate the interaction between cereal-soybean- (Cereal: barley (B), maize (M) and wheat (W)) based diets and non-starch polysaccharide (NSP) enzyme inclusion (with (+) or without (-) a xylanase and glucanase combination) on nitrogen (N) balance and ammonia nitrogen (NH_3-N) emission. The diets were formulated to have similar concentrations of DE (13.2 MJ DE/kg) and amino acids (11 g Lys/kg, 180 g CP/kg). The NSP contents of the diets were; B = 138 g/kg, M = 104 g/kg and W = 86 g/kg. Following diet adaptation, boars were housed in metabolism crates fitted with urine and feces separators for 12 d (5 d adaptation and 7 d N balance). An *in-vitro* measurement of NH_3-N emitted over 10 d and recovered from the headspace-air drawn over the surface of a fresh slurry sample collected during the N balance experiment, was performed. Volatile fatty acid (VFA) content in feces was quantified and qualified by HPLC. Boars fed B- or M-based diets had lower digestibility of ($P < 0.05$) DM (DMD), GE (GED) and lower urinary N to fecal N excretion ratio than boars fed W-based diets. Apparent digestibility of N was lower ($P < 0.02$) in B- compared to W-. N retention was not affected by cereal type. The addition of enzymes reduced ($P < 0.05$) DMD and GED in B and M, however there was no effect in W. The addition of enzymes reduced the digestibility of acid

detergent fibre ($P < 0.001$) and total VFA concentration ($P < 0.05$) in B but had no significant effect in M and W. Both urinary and faecal pH were lower ($P < 0.05$) in B- compared to M- and W-, however enzyme addition increased fecal and urinary pH ($P < 0.05$) in B+. NH_3-N from B- was lower ($P < 0.05$) than M- and W-. Enzyme addition increased ($P < 0.05$) NH_3-N by 58% in B and reduced ($P < 0.05$) NH_3-N by 27% in W. In conclusion, there appears to be interaction between cereals and enzymes in terms of nitrogen efficiency.

Key Words: Boars, Nitrogen Balance, Ammonia

207 Effects of increasing calcium:phosphorus ratio in diets containing phytase on growth performance of grow-finish pigs.

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

Our objective was to determine the effects of increased total calcium to phosphorus (Ca:P) ratio on growth performance of grow-finish pigs with diets containing phytase. A total of 144 grow-finish pigs (72 barrows and 72 gilts; initially 38.6 kg BW) were blocked by weight and sex, and then allotted to one of four dietary treatments. Each treatment had nine replications per sex and two pigs per pen. Diets were corn-soybean meal-based and fed in three phases. In each phase, diets were formulated to have Ca:P ratios of 1:1, 1.25:1, 1.5:1, or 2:1. Diets were formulated to contain 0.44, 0.39, and 0.34% phosphorus from 32 to 59, 59 to 86, and 86 to 113 kg, respectively. All diets contained 0.05% phytase from Natuphos®, providing 300 FTU/kg. For the overall experiment, increasing Ca:P ratio decreased ADG (linear $P < 0.002$) and ADFI (linear $P < 0.05$). However, the greatest decrease was observed when Ca:P ratio increased from 1.5:1 to 2:1. Feed efficiency was not affected by Ca:P ratio. As Ca:P ratio increased from 1.5:1 to 2:1 ratio, carcass weight decreased (linear $P < 0.005$). There were no differences in percent yield, backfat, loin eye area, and fat free lean index. In conclusion, these data suggest that diets containing 300 FTU/kg phytase should not have total calcium to phosphorus ratio of greater than 1.5:1 when fed to growing-finishing pigs.

	Ca:P Ratio				
	1.0:1	1.25:1	1.5:1	2:1	SED
ADG, kg	0.89	0.88	0.90	0.83	0.02
ADFI, kg	2.49	2.46	2.51	2.39	0.05
Gain/feed	0.36	0.36	0.36	0.35	0.008

Key Words: Calcium, Phosphorus, Phytase

208 Current status and review of factors involved in nutritional immunology of swine.

M. E. Spurlock*, *Purdue University, West Lafayette, IN*.

Currently, pigs reared commercially achieve 70% or less of their genetic potential for growth and efficiency. The consensus opinion is that pathogenic and nonpathogenic disease factors culminate in a series of stress and immunological responses that attenuate the animals' ability to grow. Thus, a detailed understanding of immunology and stress biology may offer new strategies for improving growth and efficiency. Recent discoveries have established a new paradigm for the adipocyte that extends well beyond the simple storage of excess energy. This cell produces a myriad of hormones and cytokines that regulate energy balance, glucose and fatty acid utilization, and specific immune response pathways. Of particular interest, the adipocyte expresses the lipopolysaccharide receptor (Tlr-4) and the lipopolysaccharide binding protein. These critical signaling proteins enable the adipocyte to respond directly to lipopolysaccharide. Indeed, lipopolysaccharide signaling in pig adipocytes results in translocation of nuclear factor kappa-B to the nucleus and altered gene expression profiles. Energy balance and adiposity have been linked to the production of certain immune modulators in the adipocyte, and may influence the functionality of key pathways. This new paradigm for adipocyte biology, energy balance, and immunity will be discussed in light of the marked reduction in adiposity achieved in commercial genotypes in the past decade.

Key Words: Growth, Immune Function, Stress

209 Involvement of trace metals in immunocompetence.

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Experimental, field and clinical trials with laboratory rodents, domestic animals and humans during the past several decades have clearly shown that both deficiencies and excesses of the essential trace metals impair defense against infectious agents. Both the innate and acquired branches of the immune system are susceptible to trace metal malnutrition. Descriptions of processes associated with the maturation, activation and effector activities of immune cells that are compromised in response to such malnutrition clearly demonstrate the central importance of these micronutrients in maintaining a robust host defense. Encouraging results from some trials also support the potential benefits of judicious supplementation for the prevention and reduction in severity of selective infectious diseases. However, insights regarding specific biochemical events that are dependent on an adequate supply of trace elements remain limited. The application of cellular and molecular methods are beginning to yield novel information about the importance of the micronutrients for the regulation of immune cell development and early events in host responses to infectious insults. In addition, the elegant studies of Beck and associates have provided a clear demonstration that changes in trace metal status have the potential to enhance the fitness of the infectious agent as well as to compromise host immune function. Changes in cellular redox status associated with deficiencies of micronutrients participating in the antioxidant defense system or excess levels of oxidative metals facilitate genotypic changes that induce virulence. Elucidation of biochemical events that are dependent on specific trace elements in host defense cells and the regulation of the transport and metabolism of these elements in health and disease provide intriguing challenges directed at defining optimal trace metal nutrition for immunocompetence (Supported by USDA NRICGP).

Key Words: Trace minerals, Immune function

210 Involvement of vitamins in immunocompetence.

R. W. Johnson*, *University of Illinois, Champaign-Urbana*.

Animals live surrounded by pathogenic microorganisms#bacteria, viruses, and parasites that can cause infectious disease. In spite of everything, animals become ill infrequently because they are equipped with a highly evolved immune system that affords protection against infectious microorganisms. Nutrition can profoundly impact both innate and adaptive immune responses of animals and thus their resistance to infectious disease. This presentation examines the effects of vitamins on immunocompetence. Special attention is given to antioxidants such as α-tocopherol and selenium. Supplementation of animals with antioxidant vitamins has been shown to potentiate antibody responses to a variety of killed preparations or live organisms. Recent evidence suggests that vitamin E, as well as other antioxidants, may reduce inflammatory cytokine production in sick animals. The potential of vitamin supplementation to prevent infectious disease or to reduce the severity and duration of infectious disease is discussed.

Key Words: Vitamins, Immune Function

211 Involvement of fatty acids in immunocompetence.

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The two major objectives of this presentation will be (1) to review the evidence that dietary fat affect the immune system and infectious disease resistance in domestic animals; and (2) to describe our current understanding of the mechanisms underlying these effects. This review will focus on animal feeding trials with poultry and swine. The current data suggest that the addition of certain fatty acids, particularly omega-3 polyunsaturated fatty acids (i.e., n-3 PUFA), to standard livestock rations can significantly alter in vivo inflammatory responses and improve host resistance to some pathogens. However, the data are still quite limited. An important area of research at present is defining the immunological parameters which predict the impact that diet manipulations have on host disease resistance. The current view for how fatty acids affect the immune system is centered on the ability of some to alter cytokine and eicosanoid production. The role of a novel family of transcription factors (i.e., peroxisome-proliferator activated receptors, PPARs) as conveyors of fatty acid modulation of immune cell function

will be described. While much less in known about how fat might impact the immune system in ruminants, opportunities for future research in this area will be presented as well.

Key Words: Fatty Acids, Immune Function

212 Effect of dietary bilobalide on mitochondrial bioenergetics and body growth in rats. T. R. Lutz* and T. S. Stahly, *Iowa State Univeristy, Ames*.

Proton leak accounts for up to 20% of the standard metabolic rate in rats with skeletal muscle having a particularly high proportion (50%) of its energy lost as proton leak at steady state conditions. Therefore, identifying compounds with the ability to reduce the proportion of energy lost due to proton leak could improve the efficiency of mitochondrial energy metabolism and body growth. The objective of this study was to determine the effects of dietary addition of bilobalide on muscle and liver mitochondrial bioenergetics and body growth in rats. Weanling rats (16/trt) were individually penned and allowed ad libitum access to a diet containing either 0 or 78 ppm bilobalide for 22 d post-weaning. Gastrocnemius (16/trt) and liver mitochondria (8/trt) were isolated and State 3 (maximal rate of respiration) and State 4 (proton leak-dependent respiration) oxygen consumption rates and the respiratory control ratio (RCR=State3/State4), an index of respiratory chain coupling, were measured. Bilobalide addition did not ($P > 0.10$) alter gastrocnemius weight or mitochondrial protein content, State 3 (158 vs 147 nmol $O \cdot min^{-1} \cdot mg\ protein^{-1}$) or State 4 rates or the RCR (6.1 vs 5.8). However, dietary bilobalide addition resulted in increased liver weights (12.0 vs 10.8 g; $P < 0.01$) and mitochondrial protein contents (11.6 vs 9.7 mg/g of liver; $P < 0.01$). Bilobalide addition also increased liver mitochondrial State 3 rates (33 vs 28 nmol $O \cdot min^{-1} \cdot mg\ protein^{-1}$; $P < 0.05$) and RCR (5.3 vs 4.5; $P = 0.08$), but State 4 rates were unaltered. Dietary bilobalide did not alter daily body weight gain, feed intake, efficiency of feed utilization or the weight of the epididymal fat pad. Based on these data, bilobalide, ingested orally, minimizes the proportion of energy in liver lost due to proton leak, but does not alter muscle mitochondrial bioenergetics or rate and efficiency of body growth.

Key Words: Mitochondria, Bilobalide, Bioenergetics

213 Dietary fat sources for weanling pigs. R. Sulabo* and H. H. Stein, *South Dakota State University, Brookings*.

The effect of including three different fat sources in diets for newly weaned pigs was evaluated in a five wk experiment. A total of 96 pigs were weaned at an average age of 20 d and allotted to four different treatment groups based on BW, ancestry, and sex. There were four pigs/pen and six replicate pens/treatment group. A phase 1 control diet (1.5% Lys, 3,281 kcal ME/kg) based on corn, soybean meal, whey powder, fish meal, and protein plasma, was formulated. The phase 2 control diet (3,296 kcal/kg, 1.15% Lys) contained corn, soybean meal, and fish meal. The control diets were fed to pigs on treatment group 1. Diets for pigs on treatment groups 2, 3, and 4 were identical to the control diets with the exception that 6% fat was added to each of the diets at the expense of corn. The fat sources used were animal fat (treatment group 2), soybean oil (treatment group 3), and sunflower oil (treatment group 4). To maintain a constant Lys concentration, the inclusion of soybean meal was slightly increased in the diets containing the supplemental fat sources. The phase 1 diets were provided during the initial 2 wk post-weaning while the phase 2 diets were fed during the remaining 3 wk of the experiment. Average daily gain, ADFI, and gain:feed ratios (G:F) were calculated for each of the two phases and overall for the entire period. The ADG during phase 1, phase 2, and phase 1 and 2 combined were not affected ($P > 0.05$) by dietary treatments (184, 168, 190, 199; 338, 354, 382, 353; and 277, 280, 305, 291 g/day for pigs on treatment groups 1, 2, 3, and 4, respectively). Likewise, ADFI was not affected by dietary treatments, for phase 1, phase 2, or phase 1 and 2 combined ($P > 0.05$). The values calculated for G:F were 0.68, 0.66, 0.70, and 0.72 (phase 1), 0.55, 0.59, 0.62, and 0.56 (phase 2) and 0.58, 0.61, 0.64, and 0.59 (entire period) for pigs on treatment groups 1, 2, 3, and 4, respectively). Within each phase, none of these values were different ($P > 0.05$). The results of this experiment indicate that pig performance during the immediate post-weaning period is not improved significantly by the inclusion of dietary fat. Furthermore, no differences between the three fat sources evaluated in this experiment were detected.

Key Words: Dietary Fat, Pigs, Energy Concentration

214 Effects of fat encapsulation and pelleting on weanling pig performance and nutrient digestibility. J. J. Xing[1,2], E. van Heugten[1], D. F. Li[2], K. J. Touchette[3], J. A. Coalson[3], and J. Odle*[1], [1]*North Carolina State University, Raleigh,* [2]*China Agriculture University, Beijing,* [3]*Merrick's, Inc., Union Center, WI*.

The objective of this study was to evaluate the effects of encapsulated fat (EF) processed by spray drying on growth and nutrient digestibility in weanling pigs. A total of 144 pigs (6.04 kg BW, weaned at 21 d) were allotted to 1 of 6 treatments in a 3 x 2 factorial arrangement with 3 levels/sources of fat (1 or 6% fat from unprocessed lard, or 6% fat from EF) and 2 diet forms (mash vs pellet). Pigs were fed a 2-phase diet program, with phase 1 diets fed from d 0-14 and phase 2 diets fed from d 14-35. Total-tract digestibilities were computed using chromic oxide as marker. Fat addition to the diet reduced ($P < 0.05$) ADFI from d 0 to 14, with no effect on ADG or G/F. From d 14 to 28, EF improved ADG ($P < .005$) and G/F ($P < 0.01$) each by greater than 10%, with no effect on ADFI. For the entire 35 d trial, fat supplementation decreased ADFI by 6% ($P < 0.05$), with no effects on ADG or G/F, while EF did not affect pig performance. Pelleting improved ADG ($P < 0.01$) and G/F ($P < 0.05$) during phase 1, with no effect on ADFI. During phase 2, and overall (d 0-35), pelleting decreased ADFI ($P < 0.06$) and improved G/F ($P < 0.01$) by 5-8%, with no effect on ADG. Fat level/source did not affect ($P > 0.05$) DM or organic matter (OM) digestibility; however, pelleting improved ($P < 0.001$) DM, OM and fat digestibility of all diets. Fat addition improved fat digestibility compared to 1% lard ($P < 0.001$). Pellet durability index was numerically higher (96.2% vs 85.6%) in the EF phase 2 diet compared to the lard diet. In conclusion, the EF improved growth and feed efficiency in weaned pigs, with d 14 to 28 being most beneficial. Encapuslated fat may improve pellet quality of phase 2 nuresery pig diets containing high levels of fat and low levels of whey. Additionally, pelleting improved digestibility and feed efficiency during the post-weaning period in pigs.

Key Words: Encapsulated Fat, Pigs, Fat Digestibility

215 Growth performance of nursery pigs fed diets containing increasing levels of corn distiller's dried grains with solubles. M. H. Whitney* and G. C. Shurson, *University of Minnesota, St. Paul*.

Two trials were conducted to determine the effects of including increasing levels of corn distiller's dried grains with solubles (DDGS) in Phase II and Phase III diets for early-weaned pigs on growth performance to determine a recommended maximum DDGS inclusion rate. A high quality DDGS source, produced by a modern MN ethanol plant, was used. Ninety-six crossbred pigs (BW = 6.18 ± 0.14 kg) were blocked by gender and ancestry, and blocks randomly assigned to one of six dietary treatments (4 pigs/pen, 4 pens/treatment) in each trial. Pigs in Trial 1 were slightly older (19.0 vs. 16.9 d of age) and heavier (7.10 vs. 5.26 kg) at the beginning of the trial compared to pigs in Trial 2. Dietary treatments consisted of including 0, 5, 10, 15, 20, or 25% DDGS in typical Phase II and Phase III diets in a 3-phase nursery feeding program. All pigs were fed a commercial Phase I pelleted diet for the first 4 d post-weaning. Pigs were subsequently fed their respective Phase 2 experimental diets for 14 d, followed by their respective Phase 3 experimental diets for an additional 21 d feeding period. Experimental diets were formulated to contain equivalent apparent ileal digestible Lys (1.35 and 1.15%) and Met + Cys (0.80 and 0.65%), ME (3340 and 3390 kcal/kg), calcium (0.95 and 0.80%), and total phosphorus (0.80 and 0.70%) within Phases 2 and 3, respectively. Overall ADG, final BW, and G/F were similar regardless of dietary DDGS level in both trials ($P > 0.10$). In Trial 1, feed intake was unaffected by dietary level of DDGS ($P > 0.10$). However, in Trial 2, increasing levels of DDGS linearly reduced average daily feed intake ($P < 0.05$) during Phase II, resulting in a slight overall depression in voluntary feed intake ($P < 0.10$) for the entire length of the trial. These results suggest that using high quality DDGS, and formulating diets using the University of Minnesota apparent amino acid digestibility values for DDGS, provides satisfactory growth performance when included at rates up to 25% in Phase III nursery diets. It appears that feeding DDGS at levels up to 25% of the diet may also be satisfactory in Phase II for pigs weaned at 19 d of age or older and weighing > 7 kg,

but initial feed intake may be depressed during Phase II when DDGS is fed to pigs weaned at younger ages (17 d of age or less).

Key Words: Distiller's Dried Grains with Solubles, Swine, Nursery

216 Feed intake and energy digestibility among wheat classes fed to weaned pigs. R.T. Zijlstra*[1], D. Overend[2], D. R. Hickling[3], P. H. Simmins[4], and J. F. Patience[1], [1]*Prairie Swine Centre Inc., Saskatoon, SK,* [2]*Ridley Inc., Mankato, MN,* [3]*Canadian International Grains Institute, Winnipeg, MB,* [4]*Danisco Animal Nutrition, Marlborough, UK.*

The nutritional quality of wheat is expected to vary among classes; therefore, Soft and Durum wheat are separated. A range in wheat CP and non-starch polysaccharide (NSP) partly causes the variation in quality. Two cultivars from each of six classes (Soft White, Soft Red, Durum, Hard Red Spring (HRS), Hard Red Winter (HRW) and Hard White (HW)) were collected. Crude protein (as-is) ranged from 12.2 to 17.4% for all, 12.4 to 16.1% for Soft, and 16.3 to 16.8% for Durum. Total NSP ranged from 9.0 to 11.5% for all, 11.0 to 11.4% for Soft, and 9.0 to 10.1% for Durum. A 3-wk growth and digestibility study was conducted with 12-kg weaned pigs (PIC; 39-d-old; 4 pigs/pen, 12 pens per cultivar) fed 65%-wheat diets (3.5 Mcal DE/kg; 3.4 g digestible Lys/Mcal). For d 0 to 21, ADG, ADFI, and feed efficiency did not differ among wheat classes ($P > 0.10$). For d 0 to 7, ADG for Durum was 9% lower than for HRW ($P < 0.05$), and similar among other classes. For d 8 to 14, ADG did not differ among classes ($P > 0.10$). For d 0 to 7, ADFI for HW was 7% lower than for HRW ($P < 0.05$), and similar among other classes. For d 8 to 14, ADFI for Soft White was 5% lower than for HRS ($P < 0.05$), and similar among other classes. For d 0 to 7, feed efficiency was 4% lower for Durum than for Soft Red, HRS, and HRW ($P < 0.05$). Diet total-tract energy digestibility was lowest for Soft Red (86.5%), intermediate for Soft White, HRS and HW (87.2 to 87.5%) and highest for HRW and Durum (88.6 and 88.9%; $P < 0.05$); diet DE content followed a similar pattern. In summary, protein but not NSP content varied among 12 wheat cultivars harvested in 2001; wheat DE content ranged 7% and was highest for Durum. Decreases in ADFI and ADG for Durum and Soft wheat were limited to the first two wk, and did not exist after 3 wk. In conclusion, despite variations in DE content among wheat classes, young pigs fed all classes of wheat, including Soft and Durum, may grow adequately.

Key Words: Wheat, Pigs

217 Particle size, mill type, and added soy oil influence flowability of ground corn. C. N. Groesbeck*, R. D. Goodband, S.S. Dritz, M. D. Tokach, J. L. Nelssen, and C. W. Hastad, *Kansas State University, Manhattan.*

Decreasing particle size and adding fat to diets can improve pig performance and profitability. Limits to reducing grain particle size and amount of added fat are frequently based on the ability of the feed to flow through feed delivery systems and feeders. Additionally, grain ground with a roller mill typically has a more uniform particle size than that ground with a hammer mill. Thus, type of grinding is expected to affect feed flowability. Therefore, our objective was to evaluate the effects of mill type, particle size and added soy oil on the flowability of ground corn. Six different particle size samples were evaluated for each mill type. The particle size mean and standard deviation for the corn ground with a roller mill ranged from 1,235 (1.98) to 502 (1.97) and for the hammer-milled corn ranged from 980 (2.52), to 390 (2.12) microns. All samples were dried overnight and equilibrated to equal moisture content. Soy oil was then added at 0, 2, 4, 6, and 8 % to portions of each sample. Flowability was determined by measuring angle of repose (the maximum angle measured in degrees at which a pile of grain retains its slope). A large angle of repose represents a steeper slope and poorer flowability. There was a three way interaction between particle size, soy oil, and mill type ($P < 0.05$). Corn ground with a hammer mill without added soy oil had a similar angle of repose as the corn ground with a roller mill that had 6 % added soy oil. Angle of repose was increased as particle size was decreased and more soy oil was added. However, the rate of increase was lower as particle size was decreased and at reduced particle sizes the rate of increase was greater for hammer-milled corn compared to roller-milled corn. These data indicate that corn ground with a roller mill that has 6 % added soy oil should have similar flowability as hammer-milled corn without added soy oil.

Key Words: Particle Size, Hammer Mill, Roller Mill

218 Evaluation of dehulled, degermed corn for swine. D. C. Kendall*[1], A. M. Gaines[1], J. W. Frank[1], G. L. Allee[1], M. Bertram[2], and T. E. Sauber[3], [1]*University of Missouri, Columbia,* [2]*Pork Technologies, LLC, Ames, IA,* [3]*Pioneer-Dupont, West Des Moines, IA.*

Three experiments were conducted to determine the feeding value of dehulled, degermed (DD) corn for swine. In Exp. 1, 12 barrows (TR-4 × PIC C-22) were placed in metabolism crates and used in two 4-d collection periods to determine digestible energy (DE) values and apparent fecal digestibility in DD compared to normal corn. The dietary treatments were composed of 97.2% of either DD corn or normal corn and 2.8% of a mineral and vitamin premix. In Exp. 2, 98 barrows (TR-4 × PIC C-22) were used to determine if DD corn could be fed to pigs throughout the growing-finishing phase. Pigs were housed at 7 pigs/pen (7 reps/diet) and fed pelleted diets formulated to meet or exceed NRC (1998) recommendations for each phase of growth. Dietary phases occurred at 32-45, 45-64, 64-82, 82-100, 100-118 kg BW. In Exp. 3, 20 crossbred growing and 12 finishing barrows (TR-4 × PIC C-22) were used to determine the apparent fecal energy digestibility and fecal DM output of the diets from each phase in Exp. 2. In Exp. 1, apparent energy digestibility values were higher for pigs fed DD corn than normal corn (96.6 vs 88.3%, $P < 0.001$). DE values were higher for DD corn than for normal corn (4051 vs 3791 kcal/kg, $P < 0.001$). In Exp. 2, performance for the overall finishing period showed ADG was similar between the two corn sources, but ADFI was 6.3% lower ($P < 0.02$) and G:F was 5.4% higher ($P < 0.001$) for pigs consuming DD corn compared to normal corn. There was also higher mortality for pigs fed DD corn (18.4 vs 0%; $P < 0.004$), caused by gastric ulcers. The increased mortality can partially be attributed to small particle size (310 microns), a pelleted diet, and prolonged feeding of the DD corn. In Exp. 3, apparent fecal digestibility of energy was higher ($P < 0.001$) in each phase of growth for pigs fed DD corn compared to normal corn (0.96, 0.964, 0.971, 0.975, and 0.978 vs 0.924, 0.933, 0.922, 0.951, and 0.958%, respectively). The decrease in fecal DM output ranged from 42 to 60% ($P < 0.001$) when pigs were fed DD corn. These experiments demonstrate that DD corn can be utilized to increase diet digestibility and decrease fecal output, but factors contributing to gastric ulcers must be considered.

Key Words: Pigs, Dehulled Degermed, Corn

219 Comparison of grain sources (barley, white corn, and yellow corn) for swine diets and effects on performance and carcass traits. J. F. Lampe*, T. J. Baas, and J. W. Mabry, *Iowa State University, Ames.*

An experiment was conducted to evaluate the effect of energy source on performance and carcass traits of pigs. Dietary treatments (primary energy source) were: 1) yellow corn, 2) white corn, 3) 1/3 yellow corn, 2/3 white corn, 4) 2/3 yellow corn, 1/3 white corn, 5) barley. Pigs were from two sires lines, Duroc and Hamp x Duroc, on PIC 1055 females. Pigs were randomly allocated to pens based on genetic type and gender using a 2 x 2 x 5 factorial arrangement with two genetic types, two sexes (barrows and gilts) and five dietary treatments. There were 8 pens per treatment with 26 pigs per pen. Diets were fed in four phases: phase one (27.6 to 49.3 kg), phase two (49.3 to 67.2 kg), phase three (67.2 to 103.3 kg), and phase four (103.3 to 130.2 kg). Diets were formulated to contain 1.12% Lys, 0.83% Ca, and 0.71% P; 0.93% Lys, 0.73% Ca, and 00.56% P; 0.71% Lys, 0.65% Ca, and 0.52% P; 0.65% Lys, 0.63% Ca, and 0.46% P for phases 1 to 4, respectively. Diets were supplemented with choice white grease, to maintain an iso-caloric status through phases one and two (67.2 kg). Choice white grease was limited to 1% in phases three and four (67.2 to 130.2 kg). Backfat (BF) and loin muscle area (LMA) were estimated one d prior to harvest by a trained technician using real-time ultrasound. Diet had no effect ($P > 0.05$) on ADG, ADFI, feed conversion (FG), ultrasound BF, or percent fat-free lean (FFL). Pigs fed diet 5 had a smaller ($P < 0.05$) LMA than pigs fed the other four diets. Pigs fed diet 5 had lower lean gain on test (LGOT) than pigs fed diets 1, 2 and 4, although diet 3 was not different ($P > 0.05$) from all treatment means. Duroc-sired pigs had greater ($P < 0.05$) LMA, LGOT, FFL, ADFI, and FG than Hamp x Duroc-sired pigs. Duroc-sired pigs had less ($P < 0.05$) BF than Hamp x Duroc-sired pigs. Results suggest that

yellow or white corn, or barley as the primary energy source did not effect pig growth performance; however, pigs fed barley as the primary energy source had smaller LMA than pigs fed yellow or white corn.

Key Words: Pigs, Energy Sources, Carcass

220 Comparison of Grain Sources (Barley, White Corn, and Yellow Corn) for Swine Diets and Their Effect on Meat and Eating Quality Traits. J.F. Lampe*[1], T.J. Baas[1], and J.W. Mabry[1], [1]*Iowa State University*.

An experiment was conducted to evaluate the effect of energy source on meat and eating quality characteristics of the longissimus muscle of pigs. Diet treatments (primary energy sources) were: 1) yellow corn, 2) white corn, 3) 1/3 yellow corn, 2/3 white corn, 4) 2/3 yellow corn, 1/3 white corn, 5) barley. Pigs were from two genetic sire lines, Duroc and Hamp x Duroc sires (HD) on PIC 1055 females. A total of 999 pigs were included in the trial in a 2 x 2 x 5 factorial arrangement with two genetic types, two sexes (barrows and gilts) and five treatments. Eight pigs were randomly selected from each pen of 26 (n= 319) for meat and eating quality evaluation. Pigs were placed on test at 27.6 kg and fed to 130.2 kg. The final phases of the finishing diets (67.2 to 130.2 kg) included 1% supplemented choice white grease. All animals were held overnight at a commercial abattoir before harvest. One whole skin-on, boneless loin was collected from each carcass and held at -1 degree Celsius in a cryovac sealed bag at the Iowa State University Meat Lab. At 25 to 27 days post-harvest, loins were analyzed for meat and eating quality. Diet treatment had no effect ($P > 0.05$) on 24 hour pH, sensory tenderness, sensory chewiness, Instron tenderness, loin purge, and cook loss. Pigs fed diet 4 had a higher ($P< 0.05$) loin pH than pigs fed diet 1 at 25 to 27 days post-harvest, although diets 2, 3, and 5, were not different from all treatment means. Pigs fed diet 4 had a higher ($P < 0.05$) Japanese color score than pigs fed diets 2, 3, and 5, although diet 1 was not different from all treatment means. Pigs fed diet 3 had a higher percent intramuscular fat than diets 1 and 2, although diets 1, 4, and 5, and diets 1, 2, and 5, were not different ($P > 0.05$). Duroc-sired pigs had a higher ($P < 0.05$) 24 hour pH and Japanese color, and lower ($P < 0.05$) hunter color values than HD-sired pigs. Results suggest that different energy sources evaluated in this study have little effect on eating quality of pork that is held for 25 - 27 days post harvest.

Key Words: Pigs, Energy Sources, Quality

221 Effects of a white versus yellow corn variety on growth performance and carcass characteristics of growing-finishing pigs. R. W. Fent*[1], G. L. Allee[1], S. N. Carr[2], F. K. McKeith[2], G. F. Hartnell[3], and P. D. Matzat[3], [1]*University of Missouri, Columbia,* [2]*University of Illinois, Urbana-Champaign,* [3]*Monsanto Company, St. Louis, MO*.

A total of 340 pigs (170 gilts, 170 barrows) initially averaging 27.0 kg BW were utilized in a growing-finishing experiment to evaluate the effect of two corn genotypes on growth performance and carcass composition. Pigs were allotted by sex to one of two treatments using a completely randomized design with twenty pens per treatment containing eight or nine pigs per pen. Treatments consisted of either a yellow or white corn variety substituted for one another as the sole grain source in corn-soybean meal-based diets fed in a five-phase split-sex feeding program. Pig weight, real-time ultrasound measures, and feed intake were determined at dietary phase changes and at the experiment completion. At termination of the experiment (116 kg BW), eighty pigs (two/pen) were utilized for in-depth carcass analysis. The white corn diet resulted in slightly greater ADG (0.91 vs 0.89 kg/d; $P < 0.02$), but ADFI (2.46 vs 2.43 kg/d) and gain:feed were similar ($P > 0.05$) for both treatments (0.368 vs 0.370). Ultrasound tenth rib fat depth and loin eye area were similar ($P > 0.05$) across dietary treatments at both initiation and termination of the experiment. No differences ($P > 0.05$) were observed between treatments for lean color, marbling, firmness, and pH measures. In general, backfat fatty acid profiles and backfat color were similar ($P > 0.05$) for both dietary treatments. However, backfat from pigs consuming white corn had greater ($P < 0.03$) linoleic acid content versus those fed yellow corn. Shear force ($P < 0.08$) tended to be greater in loins from pigs fed yellow corn versus those fed white corn-based diets. Taste panel analysis indicated that although no differences ($P > 0.05$) were observed for juiciness or off-flavor intensity, loins from pigs fed white corn tended ($P < 0.07$) to be more tender than those fed yellow corn. These data suggest that growth performance, carcass parameters, and meat quality were generally similar for growing-finishing pigs fed either the white corn variety or the yellow variety with only minor differences occurring in fat quality and loin measurements.

Key Words: White Corn, Growing-Finishing Pigs, Carcass

222 Virginiamycin influences mineral digestibility of pigs. J. H. Agudelo*[1], M. D. Lindemann[1], G. L. Cromwell[1], and R. D. Nimmo[2], [1]*University of Kentucky, Lexington,* [2]*Phibro Animal Health, Fairfield, NJ*.

A balance study was conducted to evaluate the effect of virginiamycin on the absorption and retention of minerals (P, Ca, K, Fe, Mg, Zn, Cu and Mn) in finishing pigs. Ten crossbred barrows (53.9 kg and 84 d of age) were paired and randomly assigned to two treatments (0 or 10 g/ton virginiamycin). The corn-soybean meal diet without supplemental P met all NRC (1998) requirement estimates, except for P. The pigs were placed in individual metabolism crates for a 7-d adaptation and 5-d collection period, and fed at 3% of BW/d in two meals. Water was supplied ad libitum during non-feeding times. The beginning and end of the collection phases were marked by the addition of indigo blue dye to the diet. After the first collection phase, pigs were switched to the alternate diet, provided a 3-d respite from the crates, and then the adaptation-collection procedure was repeated. Orts were obtained only during the initial 2 to 3 days of the adaptation periods but did not occur during collections. ADG (1.03 vs 1.14 kg) and F/G (2.33 vs 2.01) did not differ during the collection period ($P > 0.1$) for pigs fed the control and virginiamycin diets, respectively. The apparent digestibilities (%) of P (30.4 vs 38.8, $P < 0.01$), Ca (51.5 vs 57.3, $P < 0.01$), Mg (55.1 vs 58.2, $P < 0.02$), and Zn (23.6 vs 27.5, $P < 0.01$) were improved by virginiamycin. Apparent digestibilities of other minerals (K, Fe, Cu and Mn) were not affected ($P > 0.1$). Absolute retention of P (2.4 vs 3.2 g/d), Ca (3.5 vs 4.2 g/d), Mg (1.1 vs 1.2 g/d) and Zn (14 vs 17 mg/d) was improved ($P < 0.05$) with virginiamycin addition while other minerals were not affected. Increases in retention were the sole result of increases in digestibility with the exception of phosphorus, where both retention as a percentage of intake and retention as a percentage of absorption were improved ($P < 0.02$) by virginiamycin. These results indicate that virginiamycin improves the digestibility of several minerals, most notably phosphorus, in finishing pigs.

Key Words: Minerals, Virginiamycin, Phosphorus

223 Effects of lowering dietary trace mineral (Fe, Zn and Cu) concentrations on trace mineral retention and excretion by young pigs fed diets containing low-phytic acid barley. T. L. Veum[1], D. W. Bollinger[1], M. S. Carlson*[1], D. R. Ledoux[1], and V. Raboy[2], [1]*University of Missouri, Columbia,* [2]*USDA-ARS National Small Grains Germplasm Research Facility, Aberdeen, ID*.

The nutritional effects of a genetically enhanced, low-phytic acid mutant barley (MB) compared to the near-isogenic normal Harrington barley (HB) on trace mineral absorption, retention and excretion were evaluated in growing swine. The estimated percentage availability of P was 90 to 95% in MB and 30% in HB. The effects on growth performance and bone strength have been reported (JAS 79, Suppl.2, p 71). Fifty crossbred barrows with an average BW of 9.94 kg were kept in individual stainless steel metabolism pens during the 28-d experiment. The two barley cultivars (MB and HB) and the five additions of a trace mineral premix (0, 25, 50, 75 and 100% of NRC for Fe and Zn) created ten dietary treatments in a 2 x 5 factorial arrangement of the treatments in a completely randomized design. Premix at 100% provided 160% of Cu (NRC, 1998) for 10-20 kg pigs. The Fe, Cu and Zn were sulfate salts. All other nutrients, including I, Se and Mn, were adequate. Diets containing chromic oxide (0.05%) were fed to appetite twice daily in stainless steel feeders. On days 22 to 26, total urine collections (acidified) and fecal grab samples were made twice daily. There were no interactions ($P \geq 0.2$) for barley source by Cu level criteria, with similar Cu balance responses for MB and HB. However, Zn absorption and retention was higher ($P \leq 0.01$), and Zn excretion was lower (mg/d and %), for MB than for HB at 0% Zn premix (Zn source by Zn level interaction, $P \leq 0.01$). For MB and HB, there were linear increases ($P \leq 0.01$) in the amounts of Zn absorbed, excreted and retained with increasing Zn premix. Bone Zn and Cu concentrations were similar ($P \geq 0.7$) for all ten treatments. In conclusion, Zn and Cu balance responses were similar for MB and HB at 25 to 100% trace mineral supplementation,

but Zn absorption and retention were higher for MB than HB at 0% supplementation.

Key Words: Swine, Trace Minerals, Barley

224 The effect of increasing dietary zinc concentration in phase 2 and 3 nursery diets on the growth performance of weanling pigs. C. R. Dove*, *University of Georgia, Tifton*.

A total of 300 pigs (two trials of 150 pigs each) were used to determine the effect of supplemental dietary Zn on the growth performance of weanling pigs during phase 2 and 3 of the nursery. Pigs were weaned at 21 d of age and placed on experimental treatments immediately. Pigs were housed in an environmentally controlled, slatted floor nursery with ad libitum access to feed and water. Diets were corn-soybean meal based with whey, fish meal, blood plasma and lactose added. Dietary treatments included either 200 ppm of Zn (control diet) or 3000 ppm of Zn (diets 2-6) during phase 1 (days 1-11). During phases 2 (days 12-21) and 3 (days 22-35) the control diet and diet 2 contained 200 ppm of Zn; diet 3, 500 ppm of Zn; diet 4, 1000 ppm of Zn; diet 5, 1500 ppm of Zn; and diet 6, 2000 ppm of Zn. Zinc was fed as ZnO in all diets. Pigs were weighed and feed intake recorded at the end of each phase. Data was analyzed using mixed model procedures with the pen as the experimental unit. During phase 1, the addition of 3000 ppm of Zn to the diet increased ($P < 0.05$) ADG and feed efficiency, but had no effect on ADFI intake compared to those pigs receiving 200 ppm dietary Zn. During phase 2, the addition of 2000 ppm of Zn to the diet increased ADG and ADFI ($P < 0.05$), but had no effect on feed efficiency compared to the control diet. Pigs fed 200 or 500 ppm Zn during phase 2 (diets 2 and 3) had a decreased ADG ($P < 0.05$) compared to the control diet. Average daily gain for phase 2 was 439, 387, 378, 395, 447, and 492 g/d for diets 1 through 6, respectively. During phase 3, the addition of Zn had no effect on ADG or feed efficiency. During phase 3, the addition of 1000-2000 ppm of Zn increased ADFI ($P < 0.05$) compared to the control diet. Over the 35-day study, the addition of 1500 or 2000 ppm of Zn during phases 2 and 3 increased ADG and ADFI ($P < 0.05$), but had no effect on feed efficiency compared to the control diet and those pigs fed 200 to 1000 ppm of Zn. These data confirm previous reports of the role of Zn on performance in phase 1 and indicate that additional Zn may be needed in phase 2 and 3 nursery diets to optimize the growth performance of nursery pigs.

Key Words: Zinc, Pigs, Nursery

225 Effect of phytase on tissue trace mineral concentrations, growth performance, plasma metabolites, carcass traits, and pork quality in growing-finishing pigs. J. L. Shelton*, F. M. LeMieux, L. L. Southern, and T. D. Bidner, *Louisiana State University Agricultural Center, Baton Rouge*.

An experiment was conducted to determine the interactive effects of phytase (Natuphos®) and removing the trace mineral (TM) premix in diets for growing-finishing pigs. Pigs (initial and final BW of 22 and 109 kg, respectively) were allotted to four treatments with six replications (three barrow and three gilt) of four pigs per replicate in a randomized complete block design. The four dietary treatments were with and without the TM removed and with or without phytase in a 2×2 factorial. The Ca and aP were reduced by 0.10% in diets with phytase. Blood was collected on d-29 and at slaughter. Three pigs per replicate were randomly selected for slaughter. Overall growth performance and pork quality were not affected ($P > 0.10$) by phytase with or without the TM removed. Fasting glucose was increased ($P < 0.09$) in pigs fed the diets with the TM removed. Tenth-rib backfat thickness and liver weight were increased ($P < 0.04$) and carcass length and ham weight were decreased ($P < 0.06$) in pigs fed the diets with the TM removed. Liver weight was decreased ($P < 0.01$) in pigs fed the diets with phytase, but the decrease was greater in pigs fed the diets with the TM removed (phytase × TM, $P < 0.03$). Copper and Fe levels in the bile, Cu and Zn levels in the liver, and Zn levels in the muscle were decreased ($P < 0.06$) in pigs fed the diet with the TM removed. Phytase addition decreased ($P < 0.04$) Fe levels in the bile, increased ($P < 0.10$) Cu levels in the muscle and Zn and P levels in the liver. Manganese levels in the bile and Cu and Mn levels in the liver were decreased in pigs fed phytase in the diets with the TM removed (phytase × TM, $P < 0.04$). These data indicate that removing the TM in diets for growing-finishing pigs had no negative effects on growth performance or pork quality, but it did have negative effects on carcass traits. The addition of phytase had no negative effects on growth, carcass traits, or pork quality.

Key Words: Phytase, Pigs, Trace Minerals

226 Pharmacological zinc and phytase enhance renal and intestinal mucosa cell metallothionein protein and relative mRNA abundance in the nursery pig. M. M. Martínez*, G. M. Hill, J. E. Link, N. E. Raney, and C. W. Ernst, *Michigan State University, East Lansing, MI*.

Metallothionein (MT) is a protein that is physiologically induced by several factors, such as dietary zinc (Zn) and stress. The swine industry adds pharmacological Zn in the oxide form (ZnO) to the diets of weaned pigs as an anti-diarrheal agent. However, due to the increasing environmental concern of excessive mineral excretion and low Zn absorption caused by the high phytic acid content of plant-based diets, adding phytase has been proposed to address these concerns. The hypothesis of this study is that diets containing pharmacological Zn and phytase will increase renal and intestinal mucosa Zn, MT, and MT mRNA abundance compared to diets containing only adequate Zn. Twenty-four pigs (5.5 kg, 21 d) were fed adequate (150 ppm) Zn or one of two pharmacological concentrations (1,000 ppm; 2,000 ppm) as ZnO, without or with phytase (0, 500 FTU/kg, Natuphos®BASF). All pigs were killed after 14 d of dietary intervention. Kidney tissue was collected for analysis of Zn and MT concentrations and for RNA isolation. Duodenal intestinal mucosa cells were collected for MT analysis and for RNA isolation. Relative MT mRNA abundance was determined by dot blot analysis. Renal Zn ($P < 0.0001$) and MT ($P < 0.0003$) increased with an increase in dietary Zn. The pigs receiving phytase-supplemented diets, regardless of the dietary Zn concentration, also had an increase ($P < 0.04$) in kidney Zn. Intestinal mucosa MT protein ($P < 0.05$), and renal ($P < 0.005$) and intestinal mucosa ($P < 0.002$) relative MT mRNA abundance were greater in animals fed 2,000 ppm Zn with phytase compared to the pigs in the other dietary treatments. This study suggests that a pharmacological Zn diet supplemented with phytase enhances Zn concentration and MT synthesis in both kidney and intestinal mucosa. Furthermore, it demonstrates the regulatory role of dietary Zn on MT at the transcriptional level in the pig.

Key Words: Pharmacological Zinc, Metallothionein, Phytase

227 Body mineral composition of gilts and barrows from two genotypes of pigs from 18 to 127 kg body weight. T. G. Wiseman*, D. C. Mahan, J. C. Peters, N. D. Fastinger, S. Ching, and Y. Y. Kim, *The Ohio State University, Columbus*.

Two genotypes of pigs with different lean gain potentials [300 g vs. 400 g fat-free lean (FFL)/d], with an equal distribution of gilts (60) and barrows (60), were used to evaluate body mineral composition during the grower-finisher period. Both genotypes were housed at a single site and fed common diets during the nursery period to adjust the animals to common environmental conditions. At an average 18 kg BW the pigs were moved to a complete confinement facility and split sex fed a corn-soybean mixture that met or exceeded NRC (1998) amino acid and mineral requirements for each genotype for their lean gain potential. Six pigs for each treatment group were killed initially and at an additional four equally distributed weight intervals to 127 kg BW. The experiment was therefore a 2 × 2 × 5 factorial arrangement of treatments in a randomized complete block design conducted in two replicates. Analysis of data used the animal as the experimental unit and contrasted genotype, gender, and weight periods. The results demonstrated a quantitative linear increase ($P < 0.01$) in all macro- and micro-minerals from 18 to 127 kg BW. Pigs of higher lean gain potential had higher Zn ($P < 0.05$), Cu ($P < 0.05$), S ($P < 0.01$), and K ($P < 0.01$) body contents than those pigs with a lower FFL/d. Gilts had higher Cr ($P < 0.05$), and Fe ($P < 0.05$) contents than barrows. The differences between minerals seemed to be more pronounced and different between the groups after 100 kg BW for both genotype and sex, however, only the sex by weight interaction for Cr was significant ($P < 0.05$). These results suggest that pigs of higher lean gain potential and gilts have higher body concentrations of minerals, particularly those minerals associated with lean tissue deposition.

Key Words: Mineral, Composition, Pigs

228 Evaluation of selenium yeast (Sel-Plex^{TM}) as a selenium source in diets for 6 to 20 kg pigs. J. D. Hahn*[1], G. D. Dial[2], E. L. Hansen[1], S. A. Hansen[1], J. D. Hedges[1], B. V. Lawrence[1], and R. E. Musser[1], [1]*Hubbard Feeds, Inc., Mankato, MN,* [2]*New Fashion Pork, Jackson, MN.*

An experiment was conducted to evaluate the value of Sel-Plex^{TM} (**S-P**) as a replacement for sodium selenite (**SSE**) as the supplemental Se source in swine nursery diets. A total of 672 pigs (C22 x TR4) weighing 5.9 kg ±0.12 kg were allotted to two dietary treatments (n = 12). Pigs were housed in a conventional nursery facility at 28 pigs/pen. A three phase feeding program was used which included a 1.50% Lys phase 1 diet from day 0-7 post-weaning, a 1.40% Lys phase 2 diet from day 8-21 post-weaning, and a 1.30% Lys phase 3 diet from day 22-35 post-weaning. The control and experimental diets contained 0.3 ppm supplemental Se provided by **SSE** or **S-P** , respectively. During the day 0-7 period, a trend toward decreased ADG ($P < 0.20$) and ADFI ($P < 0.10$) was observed for the pigs fed **S-P**. Gain/feed was similar between treatments ($P > 0.50$). From day 8-21 pigs receiving the **S-P** showed a trend for improved ADG ($P = 0.20$) and gain/feed ($P < 0.10$). For the day 0-21, 22-35, and 0-35 periods, ADG, ADFI, and gain/feed were similar ($P > 0.10$) between treatments. Substitution of **S-P** for **SSE** resulted in similar performance in 6 to 20 kg pigs.

Source	SSE	S-P	CV	P<
# pens	12	12		
# pigs	336	336		
In. wt.	5.88	5.90	2.0	.73
D 0-7				
ADG, g	154.7	144.5	11.5	.18
ADFI, g	163.8	155.7	6.2	.07
GF, g/g	.94	.93	9.6	.68
D 8-21				
ADG, g	370.9	383.7	6.1	.20
ADFI, g	447.5	451.7	3.5	.52
GF, g/g	.83	.85	3.1	.06
D 0-21				
ADG, g	298.9	302.1	5.5	.64
ADFI, g	352.8	351.5	3.1	.78
GF, g/g	.85	.86	2.9	.21
D 0-35				
ADG, g	391.7	394.8	2.7	.49
ADFI, g	510.1	512.8	2.9	.68
GF, g/g	.77	.77	1.4	.34

Key Words: Selenium, Selenium Yeast, Swine

229 Use of a natural carbon-mineral supplement in swine diets: effects on pig growth and carcass characteristics. S. W. Kim[1], F. Ji*[1], R.A.M. Schmitt[2], and J. J. McGlone[1], [1]*Texas Tech University, Lubbock,* [2]*Seaboard Farms, Inc.*.

Two experiments were conducted to characterize the effects of naturally sourced iron oxide with natural, carbon-mineral characteristics (FeNCM) on growth performance and carcass characteristics as feed additives in swine diets. Four FeNCM products (DPX46162, DPX48162, DPX4600, and DPX5600) from HumaTech (Houston, TX) were evaluated. Exp. 1 used 192 pigs from weaning (3 wk of age) to market weight (102.8±2.3 kg) to test the supplemental effects of DPX46162 and DPX48162. There were three treatments (control, DPX46162, and DPX48162) with 8 pens and 8 pigs per pen in each treatment. All pigs were fed based on the 6-phase feeding program as suggested in the 1998 NRC. Body weight and feed intake were measured during each phase. Pigs were transported to Seaboard Packing Plant (Guymon, OK) when the pigs reached 102.8 kg to measure carcass characteristics. Loin pH and color were measured from the middle part of loineye at 24 h after slaughter. Pigs fed diets with DPX46162 and DPX48162 had higher ADG ($P < 0.05$) and gain/feed ($P < 0.05$) during the whole experimental period and had leaner ($P < 0.05$) carcass and higher ($P < 0.05$) loin pH 24-h postmortem than pigs from control group. Pigs fed diet with DPX had darker loin color ($P < 0.05$) and improved pass rate of loins for the Japanese market. Exp. 2 used another group of 192 pigs from weaning (3 wk of age) to market weight (112.6±2.1 kg) to test the supplemental effects of DPX4600 and DPX5600 compared with the control group. Each treatment had 8 replicate pens with 8 pigs per pen. Other design and methods were identical to those of Exp 1. There were no differences in ADG and gain/feed between control and DPX 4600 treatment. However, pigs fed DPX5600 had lower ($P < 0.05$) ADG and gain/feed than pigs fed the control diet or DPX4600. Loins from pigs fed diets with DPX4600 or DPX5600 had higher pass rates based on meat color preference for the Japanese market than loins from pigs fed the control diet. Loin pH was higher ($P < 0.05$) for pigs fed diets with DPX4600 and DPX5600 than pigs fed the control diet. These results suggest that supplementing selected FeNCM (except for DPX5600) in swine diets may improve growth performance as well as carcass characteristics.

Key Words: Pigs, Natural Carbon Mineral, Growth

230 Effects of vitamin C supplementation on plasma ascorbic acid and oxalate concentrations and meat quality in swine. S. J. Pion*, E. van Heugten, and M. T. See, *North Carolina State University, Raleigh.*

Two experiments were conducted to determine the effects of vitamin C supplementation on plasma ascorbic acid and oxalate concentrations and its effect on pork quality. In Exp. 1, 16 pigs (81.6 kg BW) were blocked by sex and weight and randomly assigned within block to one of three treatments: 1) control; 2) 1,000 mg/L vitamin C; or 3) 2,000 mg/L vitamin C supplemented in the drinking water for a 48 h period. Supplementing vitamin C increased plasma ascorbic acid (AA) levels (23.4, 19.5 and 11.6 μg/mL; $P \leq 0.05$) within 6 h of supplementation. Plasma AA levels from treated pigs declined and did not differ from the levels of the control pigs (18.6, 18.2 and 13.7 μg/mL; $P \geq 0.05$) within 2 h of ending supplementation. No differences in plasma AA levels ($P \geq 0.05$) were found between the two levels of supplementation. Vitamin C intake resulted in no differences ($P \geq 0.05$) in plasma oxalate and cortisol levels. In Exp. 2, 30 pigs (118.2 kg BW) were blocked by sex and weight and randomly assigned within block to one of three treatments: 1) control; 2) 500 mg/L vitamin C; or 3) 1000 mg/L vitamin C supplemented in the drinking water 48 h pre-slaughter. Pigs were slaughtered 4 h after vitamin C supplementation ended. Loin samples were collected for measurement of pH, color, fluid loss and oxidative stability (TBARS). Loin chops were stored at refrigerated temperatures, similar to retail display, for 4 and 8 d for analysis of color, fluid loss and oxidative stability (TBARS). At time of slaughter no differences in plasma AA, oxalate and cortisol or muscle AA and lactic acid ($P \geq 0.05$) were observed between treatments. No differences ($P \geq 0.05$) were observed in pH values between carcasses from treated or control pigs. Vitamin C supplementation failed to improve color, decrease fluid loss or improve oxidative stability. The lack of elevated plasma AA and oxalate levels at slaughter implies that timing of slaughter relative to vitamin C supplementation may be critical in order to observe potential improvements in pork quality.

Key Words: Swine, Pork Quality, Vitamin C

Abstract 366 can be found on page 91.

Odor and Nutrient Management

231 Physiological and biological limitations for nutrient utilization in farm animals. B. J. Kerr*[1], [1]*USDA-ARS-MWA-SOMMRU.*

Optimizing nutrient utilization by farm animals is vital in maintaining economical animal production in light of environmental concerns associated with agriculture. In an effort to optimize nutrient utilization, however, there are numerous physiological and biological factors preventing complete nutrient use. Except for gut fill, it was not long ago that the gastrointestinal tract was hardly considered as an organ of metabolic concern. Glutamine, a dispensable amino acid, has long been known to be a key energy substrate for the gastrointestinal tract. Only recently has Thr, an indispensable amino acid, been shown to be highly metab-

olized by gastrointestinal tissue. The metabolic fate of Thr is further complicated by the fact that crystalline Thr, which is a readily available feed ingredient, is more rapidly absorbed than protein-bound Thr. Consequently, these two metabolic conditions prevent complete utilization of dietary amino acids to be deposited into edible animal product. Another factor that impacts nutrient utilization is the relationship between diet and gastrointestinal physiology and microbial ecology. It is well known that changing dietary forage has a tremendous impact on rumen microbial ecology. The understanding of this relationship in monogastrics is lacking and complicated by sizeable microbial population that inhabit the lower gastrointestinal tract of pigs. Past research in monogastrics dealt mainly with the impact of fiber addition on animal performance with little data describing physiological or microbiological changes. In addition, characterization of the fiber type was lacking such that the changes in dietary fiber(s) consumed could not be calculated. With the current emphasis on supplementing feed ingredients or neutraceuticals targeted for selective hind gut microbial fermentation, more information is needed on the metabolic and physiological changes in the animal due to fiber supplementation. An additional area of nutrient utilization interest is the low retention of various minerals commonly supplemented in livestock feed, either due to their inability to be adequate digested or their controlled metabolic regulation. Improved utilization of nutrients will lead to a more sustainable livestock production.

Key Words: Nutrient Utilization, Amino Acids, Microbiology

232 Enhancing nutrient efficiency through genetic selection: Opportunities and challenges. M.T. See*, *North Carolina State University, Raleigh NC*.

Intensive animal agriculture has led to public and legislative concern about environmental and health risks from manure. Genetic selection for increased efficiency of production is one of many tools that can be used to decrease the amount of nutrients excreted in urine and feces. Genetic reduction of nutrient excretion from animal production systems has occurred from improved feed conversion and increased nutrient utilization. In addition, genetic improvement of reproduction optimizes the production system and leads to decreased nutrient excretion when we assume that a fixed number of animals units are produced in a location annually. Tremendous genetic progress has been observed historically for growth rate and lean composition in swine and poultry resulting in indirect improvement for feed conversion. In both industries there has been a significant reduction in days to market and increased lean yield. The annual genetic trend for milk yield has also accelerated with time producing a more efficient industry. However, intense selection for increased efficiencies has not been without challenges. Selection for efficiency has resulted in negative complications, such as reduced product quality, reduced reproductive performance, reduced appetite, and skeletal abnormalities. Genetic improvement of milk yield has likely resulted in negative effects on cow reproduction and intense selection has led to an accumulation of genetic relationships within the Holstein breed. In addition to negative genetic correlations associated with selection, production environments and production systems do not always allow animals to express their genotypes. For example, chronic heat stress, disease and other factors will result in poorer efficiency regardless of genetic merit. There is additional opportunity to enhance nutrient efficiency by directly selecting on lean tissue feed efficiency and taking into consideration not only feed costs but manure costs in developing breeding objectives. Additional genetic progress can also be made in the reproductive rates and health of all species. Improved understanding of how to profitably maximize the expression of genetic potential in commercial production situations can also enhance nutrient efficiency.

Key Words: Genetics, Efficiency, Manure

233 Reducing nutrient excretion and odor: a production system approach. G. G. Gourley*, *Swine Graphics Enterprises, Webster City, IA*..

Although extensive research has been conducted on reducing nutrient excretion and odor, the implementation and economic considerations of applying the research and technologies are unique to every production system. Some of the various products, programs, techniques, designs and technologies for dealing with nutrient excretion and odor will be reviewed. Two examples of the economic considerations and the steps in the decision process will be presented for the extensively researched feed microbial enzyme phytase, low phytic acid corn, and crystalline amino acid fortified diets. Environmental factors will be discussed including: geography, soil type, agronomic rotations of grain and/or forage, nutrient handling, storage and application considerations, as well as local, state and national regulatory factors. The impact of newer technologies on public perception and relations will also be discussed. Odor reduction strategies have been the focus of vast research efforts. Feed additives, enzymes, microbials, and amino acids have been studied extensively from the feed production perspective. Manure mangement strategies including aeration, bio- and synthetic manure covers, biofilters, and manure injection techniques have shown promise in some regions of the country. Social and good neighbor policies that go above and beyond regulations have and are quickly becoming economically important decisions not only from a production perspective, but also with respect to capital acquisition and the potential for future litigation. This presentation will provide examples of odor reduction strategies and address the economic considerations within the context of a modern swine production system.

Key Words: Nutrient Excretion, Odor, Phytase

234 Nitrogen balance on dairy operations, a comparison of three whole farm nutrient balancers. B. J. Towns* and M. A. Wattiaux, *University of Wisconsin, Madison*.

Our objectives were to determine nitrogen (N) balance on dairy operations and to compare three Farm Nutrient Balancer (FNB) spreadsheets. The FNBs were developed at the Universities of Wisconsin (WI), Maryland (MD) and Nebraska (NE). Year 2001 records from 15 farms were entered in each FNB to estimate N inputs (imported feeds, bedding, fertilizers and animals), outputs (exported crop and animal products) and balances (input - output). Also, annual N balances were calculated (1) per farm, (2) per hectare, (3) per cow, and (4) per animal unit (AU). Data were analyzed with the MIXED procedure of SAS and the CORR procedure was used to correlate N balance/ha with AU/ha. Hectares, cows, and AU per farm were 313±288, 346±351 and 554±502, respectively. Overall, N inputs, outputs, and balances (metric tons N/year) were different among farms (all $P<.01$) and averaged 57±54, 26±23 and 31±34, respectively. Estimates of N inputs were lower ($P<.001$) for NE (46 t/y) but did not differ ($P>0.05$) between WI and MD FNBs (61 and 63 t/y, respectively). The WI FNB adds N deposition as an input, whereas MD and NE FNBs do not. Also, all three FNBs calculate N fixation by legumes differently. Estimates of N outputs were highest ($P<0.001$) for WI (28 t/y), but did not differ ($P>.05$) between NE and MD FNBs (25 and 26 t/y, respectively). The WI FNB assumed a fixed milk N content while MD and NE FNBs allowed user-entry for milk protein. The four estimates of N balance did not differ between MD and WI FNBs but were lower for the NE FNB (all $P<0.01$). The N Balance averaged 72 kg/ha for NE but 117 and 120 kg/ha for WI and MD, respectively. Balance values for kg N/cow were 61, 112 and 114 and balance values for kg N/AU were 36, 63 and 65 for NE, WI and MD, respectively. N balance/ha and AU/ha for all three FNBs were significantly ($P<.05$) correlated (r=.50, .54, and .53 for MD, NE and WI, respectively). Farms with higher AU/ha had higher N balances. N balance differed among FNBs primarily because of difference in accounting for legume fixation and natural N deposition.

Key Words: Nitrogen, Nutrient Balance, Dairy Operation

235 Effect of organic vs. inorganic sources of zinc supplementation on the whole body mineral composition (Cu, Zn, Fe, Mn, P, and N) of nursery pigs. M.J. Rincker*, G.M. Hill, J.E. Link, J.E. Rowntree, J.G. Green, and D.M. Dvoracek-Driksna, *Michigan State University, East Lansing, MI*.

The use of pharmacological levels of Zn as a growth promoter in nursery pigs raises concern relating to nutrient management. A difference in metabolic management may exist between Zn Oxide (ZnO) and Zn Methionine (ZnM) to achieve Zn homeostasis. To examine this further, thirty crossbred barrows (18 2 d; 6.4 kg) were used to compare ZnO with ZnM supplementation on whole body mineral concentration in nursery pigs. Initially, six barrows were euthanized for computation of baseline (BL) mineral concentrations. The remaining twenty-four barrows were randomly allotted by body weight, within litter, to one of three dietary treatments and fed in two dietary phases (P1: d 1-7; P2: d 8-14). Dietary treatments were formulated to meet NRC recommendations (1998), excluding Zn, and consisted of: 1) negative control (NC), no supplemental Zn source; (2) NC + 2,000 ppm Zn from ZnO; and (3) NC + 2,000 ppm Zn from ZnM. Pigs were individually fed and

euthanized after 14-d. All pigs (n = 30) were ground and subsamples of whole body were collected, freeze-dried, and analyzed for P (colorimetrically), N (combustion/Leco), and Cu, Fe, Zn, and Mn (atomic absorption spectrometry). Results (DM basis) indicate that Zn supplementation increased ($P < 0.0001$) whole body Zn concentration (BL = 62.4 vs. Zn0 = 346.5 and ZnM = 358.3 mg/kg) and whole body N concentration (BL = 7.3 vs. Zn0 = 8.6 and ZnM = 8.4 mg/kg). Also, pigs fed ZnM (4.1 mg/kg) had increased ($P < 0.05$) Mn concentration in the body compared with BL (1.2 mg/kg). A similar trend ($P < 0.05$) was noted in Fe concentration (BL = 178.2 vs. ZnM = 238.2 mg/kg). Whole body concentration of Cu and P were not affected by supplemental Zn. These data suggest that feeding pharmacological levels of Zn either as an organic or an inorganic source increases the whole body Zn concentration of nursery pigs and may also have an affect on the accretion of other minerals.

Key Words: Whole Body Mineral Concentration, Nursery Pig, Zinc

236 Growth performance, carcass characteristics and nitrogen emission of grower-finisher pigs fed reduced crude protein, amino-acid supplemented, wheat-soybean diets. A.B.G. Leek*[1], W. Henry[2], and J.V. O'Doherty[1], [1]*University College Dublin, Ireland,* [2]*Devenish Nutrition Ltd., Belfast, Northern Ireland.*

Two experiments were conducted to determine the production and environmental effects of reduced crude protein (CP) wheat-soybean diets in growing-finishing swine. Dietary CP content was adjusted to 13, 16, 19 and 22 % by changing wheat and soybean meal inclusion. Levels of digestible energy and lysine were maintained at 14 MJ/kg and 11 g/kg respectively. Dietary essential amino acid content was maintained by inclusion of synthetic lysine, methionine, threonine and tryptophan. In experiment 1, designed to examine the dietary effect on growth performance and carcass characteristics, 60 individually fed pigs (9 boars and 6 gilts) were randomly assigned to each dietary treatment. Average daily feed intake (ADI), gain (ADG), feed conversion ratio (FCR) and plasma urea nitrogen (PUN) levels were measured from 40 kg to slaughter. Dietary CP level had no effect on ADG, ADI, FCR or kill out proportion ($P>.05$). Pigs fed 13 % CP had a higher P2 backfat and a lower lean meat yield than pigs fed 22 % CP ($P<.05$). PUN increased with CP level ($P<.001$). In experiment 2, using identical dietary formulations, the nitrogen (N) balance of 4 boars per treatment was investigated and replicated at 60, 70, 80 and 90 kg live weight. An *in-vitro* measurement of NH_3-N emitted over 10 days and recovered from the headspace-air drawn over the surface of a fresh slurry sample collected during the N balance experiment, was performed. N excretion was 19.3, 34.1, 37.1 and 50.6 g/d (sed=1.815; $P<.05$) in diet 13, 16, 19 and 22 % respectively. The volume of slurry produced was 3.09, 4.46, 4.12 and 6.80 kg/d (sed=0.451; $P<.001$) in diet 13, 16, 19 and 22 % respectively. NH_3-N emission was 2.53, 5.46, 5.74 and 9.71 g/d (sed=0.758; $P<.05$) per pig in diet 13, 16, 19 and 22 % CP respectively. In conclusion, reducing the crude protein content greatly reduced N excretion and N emission without affecting growth performance. However, carcass lean yield may be reduced at 13 % CP.

Key Words: Pigs, Crude Protein, Ammonia

237 Effectiveness of geotextile covers to reduce emissions from manure storage structures. J. R. Bicudo[1], C. J. Clanton[2], D. R. Schmidt[2], L. D. Jacobson[2], W. Powers[3], C. L. Tengman[4], and M. C. Bradshaw*[4], [1]*University of Kentucky,* [2]*University of Minnesota,* [3]*Iowa State University,* [4]*National Pork Board.*

Odor, hydrogen sulfide (H_2S), ammonia (NH_3) and volatile organic compounds (VOC) were measured between May and October 2000, and between April and October 2001 at three sites in Southwest Minnesota. Each site consisted of a pair of farms (nursery N1A, N1B; 2,000-head finishing F2A, F2B; 3,000-head finishing F3A, F3B). A manure storage from each pair was selected as treatment, where a geotextile cover (BioCap^{TM}) was installed. The experimental design was a completely randomized block design consisting of three different swine production types with either covered or non-covered manure storages. Data was logarithmic transformed for statistical analysis. Calculations were done using a regression approach with production type, geotextile cover, and collection year as main effects. A wind tunnel was used for collecting samples from the covered and uncovered surfaces. Flux rates for the specific gases are determined by multiplying the concentration of gas in the exhaust air by the flow rate through the tunnel. Hydrogen sulfide was measured by a Jerome meter, ammonia by boric acid collection, and volatile organic compounds solid phase micro extraction. Results showed that there was a significant deterioration of the performance of geotextile covers in reducing odor and gas emissions from manure storages on the second year of the study. Odor emissions were, in average, reduced by 48% over the two-year period. Emission rate were reduced by 90% in terms of H_2S in the first year, but no significant differences were found between covered and non-covered manure storages in 2001. NH_3 emissions were, in average, reduced by 44% in 2001. No significant differences in total-VOC emissions from covered and non-covered manure storages were observed during the two-year study. Analysis of the ambient H_2S data suggested that the covers were effective in reducing ambient H_2S concentrations near manure storages located at the two finishing sites. Odor and gaseous emission rates from all sites were poorly correlated with most manure characteristic parameters (nutrients, solids, organic matter, VOCs).

Key Words: Swine Manure, Hydrogen Sulfide, Ammonia

238 Effect of using a manure pit additive (Barrier^{TM}) on growth performance of grow-finish pigs and volatile organic compounds, ammonia, hydrogen sulfide, and odor emissions in an anaerobic deep pit swine confinement finishing facility. M. H. Whitney*, J. S. Knott, M. J. Spiehs, and G. C. Shurson, *University of Minnesota, St. Paul, MN.*

A study was conducted to determine the effect of using a commercial manure pit additive (Barrier^{TM}) on gas and odor emissions and growth performance of grow-finish pigs raised in a confinement building using an anaerobic deep pit for manure storage. The 40 pen building was mechanically ventilated with partially slotted concrete floors, and was divided into 2 rooms, each with a separate 2.45 m anaerobic deep pit. A total of 1240 pigs with average initial BW of 23 kg were allotted to rooms to provide approximately 8 pigs/pen (0.87 m^2/pig) during each of four trials. Pigs remained in their assigned pens until reaching market weight at approximately 114 kg. Barrier^{TM} was added to the assigned treatment pit on a monthly basis (0.05% vol/vol) for each trial. A 5-phase, separate sex feeding program was used. Corn-soybean meal based diets were formulated to meet or exceed NRC (1998) nutrient requirements. Pig weights and feed disappearance were determined every two wks. Air samples were collected monthly at pit (30 cm above manure surface) and pig level, and from pit fans to measure concentrations of hydrogen sulfide (H_2S), ammonia (NH_3), and volatile organic compounds (VOC). Air samples were also collected at pig level and from pit fans at the beginning, middle, and end of each trial and evaluated for odor utilizing an olfactometer and trained human odor panel. Analysis of variance with repeated measures in time (within each trial) was used to analyze all data. Addition of Barrier^{TM} to manure pits had no effect on ADG, ADFI, G/F, or days on test ($P > 0.10$). No differences in odor detection threshold, intensity, or persistence between treatments were observed ($P > 0.10$). H_2S and NH_3 concentrations were numerically reduced in pits treated with Barrier^{TM}, but due to high variability in these measurements and minimal replication, differences were not significant ($P > 0.10$). Some VOC may have been affected by pit application of this product, but further refinements in procedures for collecting and analyzing these compounds is necessary. These results suggest that the addition of Barrier^{TM} to anaerobic deep pits has no effect on odor or growth performance, but may provide some benefit for reducing H_2S and NH_3 emissions.

Key Words: Swine, Pit Additive, Odor

239 Mathematical evaluation of excess non-essential amino acid nitrogen and sulfur in feed ingredients used in swine diets. J.S. Knott* and G.C. Shurson, *University of Minnesota.*

Minimizing excess dietary nitrogen (N) and sulfer (S) is essential when formulating "environmentally friendly" swine diets. By calculating the amount of non-essential amino acid N and S in feed ingredients, it may be possible to select ingredients to minimize N and S excretion. The objective of this study was to develop a feed ingredient indexing system to rank ingredients based upon the amount of excess non-essential amino acid N and S. Chemical composition of essential amino acids (EAA) and cystine were used to calculate the contribution of N and

S to the total molecular weight of each amino acid. Concentrations of EAA and cystine, crude protein, and total S for each ingredient (n = 79) were obtained from NRC (1998). Total N was calculated by dividing crude protein values by 6.25. The sum of N and S contained in EAA and cystine was compared to the sum of the total N and S in each ingredient. Ingredients were ranked on the basis of the amount excess non-essential N and S. The percentage of total N contributed from the EAA and cystine ranged from 26.11% (whey permeate) to 58.07% (blood meal). Based upon our calculations, 41 to 74% of N contained in feed ingredients is in the form of non-essential N and other N compounds. Corn ranked 47th of 79 ingredients and contained 39.82% of the total N in EAA and cystine. Solvent extracted soybean meal ranked 15th and contained 47.59% of N in EAA and cystine. The percentage of total S contributed from methionine and cystine ranged from 554% in bakery waste to 5% in cassava meal. Theoretically, the methonine and cystine cannot contribute more than 100% of the total S in an ingredient. Calculated contributions of S from methionine and cystine exceeded 100% in 22 of the 79 ingredients. Total S values, and perhaps, methionine and cystine values of feed ingredients listed in NRC (1998) need to be re-evaluated and better defined. This information will become increasingly important to nutritionists when selecting ingredients to reduce gaseous emissions and nutrient excretion from swine facilities.

Key Words: Nutrients, Nitrogen, Sulfur

240 Effects of grazing management on sediment and phosphorus in pasture runoff. M.M. Haan*[1], J.R. Russell[1], W. Powers[1], R. Schultz[1], S. Mickelson[1], and J. Kovar[2], [1]*Iowa State University,* [2]*National Soil Tilth Laboratory, Ames, IA.*.

Three replications of five 0.4 ha smooth bromegrass paddocks with slopes up to 15° were utilized to determine the effects of grazing management on phosphorus (P) and sediment loss from pastures. Pasture management treatments included an ungrazed control (UG), summer hay harvest with winter stockpiled grazing (HS), continuous stocking to a residual sward height of 5 cm (CS5), and rotational stocking to a residual sward height of 5 cm (RS5) and 10 cm (RS10). Cattle in paddocks with the RS5 and RS10 treatments were removed to allow a 35-d rest period once desired sward heights were reached. Cattle in paddocks with the CS5 treatment were managed with a put and take method to maintain the desired sward height. Grazed paddocks were initially stocked with three mature Angus cows in May 2001. In June, August, and October of 2001 and April 2002, rainfall simulations were conducted at 6 sites within each paddock and 6 sites in a buffer zone down slope from each paddock. Rainfall simulators dripped at 7 cm/h over a 0.5 m^2 area for 1.5 h. Runoff was collected and analyzed for sediment and total and dissolved P. Simultaneous to each rainfall simulation, slope, ground cover, sward height and mass; and soil penetration resistance, surface roughness, and P and moisture concentrations were measured. Annual carrying capacities for paddocks with the UG, HS, CS5, RS5, and RS10 treatments were 0, 8, 81, 62, and 47 cow-days/ha ($P < 0.01$). Slope and pasture treatment in paddocks did not significantly affect the concentration of sediment in runoff. However, concentrations and amounts of total P in runoff from grazed paddocks were greater ($P < 0.05$) than UG and HS paddocks. Concentrations and amounts of total P in runoff from paddocks with the RS10 treatment were lower ($P < 0.05$) than paddocks with the RS5 treatment. The amounts of sediment and total P in runoff from paddocks that were grazed were greater ($P < 0.05$) than their respective buffers. Increasing the amounts of residual forage in pastures will reduce total P loss from pastures.

Key Words: Grazing, Water Quality, Phosphorus

Physiology

241 The use of haplotype information in the genetic dissection of genes affecting important traits. D. C. Ciobanu*, *Sygen International*.

Modern molecular biology and the science of genomics have opened up new and exciting possibilities to dissect complex phenotypic traits. With the human genome now nearly fully sequenced, there is an intense effort to increase the number of markers, in particular SNPs (Single Nucleotide Polymorphisms) to cover most of the genome. Using this genetic variation will substantially improve our ability to find genes/loci associated with specific diseases or quantitative traits. Multiple SNPs can be organized together in haplotypes. Haplotypes can cover a full gene, a set of genes or a part of a chromosome and carry more information than individual SNPs. In humans, haplotype variants have been shown to be associated with several diseases such as, Crohn disease, Saguenay-Lac-Saint-Jean cytochrome oxidase deficiency or type I diabetes. The construction of a comprehensive haplotype map for the human genome will greatly assist in the dissection of such complex genetic traits. SNP discovery programs are also building momentum in economically important livestock species. SNPs within coding sequences can be used to help map the transcriptome of each species and are particularly useful in identifying the genes responsible for phenotypic variation in traits with important economic impact. Recently, new economically important alleles were found in the porcine PRKAG3 (protein kinase, AMP-activated, gamma 3 subunit) gene that affect glycogen content in the muscle and the resulting pork quality. In this study, haplotype analysis revealed the effects of PRKAG3 substitutions much more clearly than the analysis of individual SNPs. While single SNPs and haplotypes are both useful in the analysis of complex traits and the identification of associated genetic variation, the use of haplotypes is found to be more powerful.

Key Words: Genome, Haplotype, SNP

242 Protein identification using mass spectrometry. R. L. Cerny*, *University of Nebraska - Lincoln*.

Protein identification is a key component in the rapidly expanding area of proteomics. The mass spectrometry facility at the University of Nebraska has been involved with the identification of proteins for the past three years. Proteins isolated using both one and two dimensional gel electrophoresis and visualized with Coommassie, Sypro Ruby (fluorescent dye), or silver staining have been analyzed. The identification protocol entails excision of the visualized protein, in-gel digestion, and peptide extraction. Two different mass spectrometric approaches have been used to characterize the proteins.

The first method is peptide mapping. This requires high resolution exact mass measurements of the tryptic peptides produced in the digestion; these data are normally obtained using MALDI-TOF mass spectrometry. The peptide masses are then searched against a database of theoretical masses of tryptic peptides of known proteins to make the identification.

The second method is based on determining the partial sequence of the individual tryptic peptides using tandem mass spectrometry. This method combines nanoflow HPLC with electrospray ionization (ESI). In our facility, these experiments are performed on a hybrid mass spectrometer, the Micromass Q-TOF. This approach provides sequence information on a number of peptides originating from throughout the protein. The data produced can again be searched against known protein databases. This method has a major advantage in situations where the protein being analyzed does not have a corresponding entry in a database. Since actual sequence information is obtained, searches can be made against EST databases as well. If there is still no identification, de novo sequencing can provide a number of partial sequences that can be used to perform BLAST searches for homologies or to develop PCR primers.

These two approaches have been used to identify proteins from a wide variety of sources. These studies include the identification of proteins found in maize mitochondria, tomato viruses, human cancer cells, rat and mouse model systems, and bovine and porcine muscle tissue and reproductive systems. Examples will be presented that demonstrate how the two approaches have been used.

Key Words: Proteomics, Mass Spectrometry, Protein Identification

243 Transport, reservoirs, and fertile life of boar spermatozoa in the female tract. R.H.F. Hunter*, *Institute for Reproductive Medicine, Hannover School of Veterinary Medicine, Germany*.

Sperm transport in gilts and sows will be considered in terms of a uterine phase and then a more complex phase in the Fallopian tubes. An overriding requirement of successful transport in the uterus is that both

utero-tubal junctions should be bathed by a sperm suspension for a time sufficient to permit formation of sperm reservoirs in the Fallopian tubes. The edematous processes of the utero-tubal junction present a formidable barrier to seminal plasma and spermatozoa. Spermatozoa negotiate this junction by swimming between the engorged papillae, thereby losing male secretions from their surface. Seminal plasma does not pass beyond the junction in bulk, nor can it be forced through under pressure. Sufficient spermatozoa to fertilize a proportion of the eggs may enter the Fallopian tubes within 15 mins of a pre-ovulatory mating, but 1-2 hours are required for enough spermatozoa to enter the tubes subsequently to fertilize 90-100% of the eggs. Thereafter, seminal contents and attendant polymorphs are largely voided from the uterine lumen. The extent of absorption of seminal plasma from the uterus still requires clarification. Fertilizing spermatozoa are arrested and stored in the caudal 1-2 cm of the isthmus before ovulation, binding to microvilli and/or cilia whilst under the influence of viscous glycoprotein secretions. Peri-ovulatory release of spermatozoa is tightly-controlled, such that initial sperm:egg ratios at the ampullary-isthmic junction are close to unity. However, this ratio changes within an hour of egg activation, but too late to compromise the block to polyspermy established in the inner region of the zona pellucida. Some 200-400 or more sperm heads may be found in the zona substance by the 4-cell stage. Completion of capacitation is suppressed during pre-ovulatory storage and only finally achieved in the fertilizing spermatozoa close to the time of ovulation. Ovarian follicular secretions, acting via local counter-current vascular transfer as well as systemically, act to regulate isthmus and sperm physiology.

Key Words: Spermatozoa, Uterus, Ovary

244 Deep uterine and uterine body insemination techniques in swine and the relationship of site of insemination to the required number of spermatozoa per inseminate. E. A. Martinez*, J. Roca, and J. M. Vazquez, *University of Murcia. Spain.*

Current procedures of pig artificial insemination (AI) usually employ 2.5-4 billion spermatozoa per insemination in a large volume of liquid (70-100 ml), which are deposited through the cervix into the uterus at insemination. Important advances are being achieved in the development of new aspects of the AI technique (i.e., improvement of extenders, tests to evaluate the viability and fertilizing ability of spermatozoa, strategies to determine the time of ovulation, etc.). However, the current requirements of volume and sperm dosage to obtain optimal fertility after standard AI still are similar to those recommended since the inception of pig AI. It is now known that a 100-fold reduction of the standard pig AI dose can be used when spermatozoa are surgically deposited next to the uterotubal junction. From these results, technical solutions for non-surgical deep uterine insemination in pigs were claimed. However, the complex anatomy of the swine genital tract, mainly the cervical canal and the length and coiled nature of the uterine horns, was the principal obstacle to development of new procedures to inseminate non-surgically into the uterus. Recently, different devices have been developed to deposit non-surgically the semen in the uterine body (uterine body insemination) or anterior third of a uterine horn (deep uterine insemination, DUI). There is little information available about the relationship between the site of insemination and the required number of spermatozoa per inseminate. Published data show that in comparison with standard AI, a 3-fold reduction or a 20-fold reduction in the number of spermatozoa inseminated can be achieved without decreasing fertility when semen is deposited into the uterine body or into the upper first third of one uterine horn, respectively. In conclusion, uterine insemination technology might have a high impact on the fresh semen AI industry by decreasing the number of boars that are used. Selection of the boars could be more rigorous and only boars that have high genetic value would be included in the AI centers. In addition, DUI technology could assist in the adoption of other biotechnologies such as frozen semen, flow sorted sperm or non-surgical embryo transfer.

Key Words: Uterine Insemination, Fresh Semen, Fertility

245 Regulating the pig estrous cycle to utilize new insemination technologies. S.K. Webel*, *United Feeds, Inc.*

Researchers have focused on methods to control the estrous cycle and time of ovulation to facilitate scheduled breeding for several decades. This presentation reviews previous research and summarizes current available techniques. Natural methods such as boar exposure, gilt management and weaning management are well documented and routinely used by swine producers. Chemical or hormonal control has focused on controlling the luteal phase or stimulating follicular development. Progesterone or synthetic progestagens have been injected, fed and administered as subcutaneous or vaginal implants. Daily injections of progesterone inhibits estrus and with adequate dosing, results in normal fertility. Several synthetic progestagens administered orally or by injection inhibit follicular growth and estrus, but in many cases result in poor synchronization, increased incidence of cystic follicles and lower fertility. A unique progestagen, Altrenogest (Regumate^{TM}) has been shown to be very effective for suppressing estrus, and produces a high level of synchronization with resultant normal fertility. Shortening the luteal phase by injection of prostaglandin has limited practical value because corpora lutea (CL) are not susceptible to lysis prior to day 12 of the cycle. However, prostaglandins may have application for regressing accessory CL or those whose lifespan has been prolonged by estrogen treatment and for premature termination of pregnancy. Effective control of the estrous cycle has been achieved with a non-steroidal compound ICI 33828, but research was curtailed following identification of teratogenic properties. Follicular development and ovulation can be stimulated with pituitary gonadotrophic preparations, PMSG, hCG, GnRH or combinations of these hormones. Follicular development can be stimulated in prepubertal gilts, anestrous sows, lactating sows and following suppression of the estrous cycle with progestagens. Following follicular stimulation, ovulation can be induced by injection of HCG or GnRH. The most readily available and effective means for regulating the pig estrous cycle is to feed Altrenogest to suppress and regulate estrus and a combination of PMSG and hCG (PG-600) to promote follicular development.

Key Words: Pig Estrus Control, Follicle Stimulation

246 Anesthetic suppression of LH concentrations in barrows. J. A. Clapper*, *South Dakota State University.*

An anesthetic consisting of 50 mg/ml each of tiletamine, zolazepam, ketamine, and xylazine (TKX), has been used for short duration surgeries in pigs, but its effects on LH concentrations are unknown. To determine if administration of TKX to pigs decreases LH concentrations and induces a stress response, as determined by an increase in serum concentrations of cortisol, the following experiment was performed. On d 1, 8 gilts and 6 barrows of similar weight (75 kg) were anesthetized with TKX (1 ml/22.5 kg BW i.m.) and indwelling jugular catheters were inserted. On d 6, blood samples were taken every 20 min for 4 h, then pigs were anesthetized with TKX and blood samples were taken every 20 min for 4 h. On d 8, blood samples were collected every 20 min for 4 h, then pigs were anesthetized with sodium thiopental (PEN; 8.9 mg/kg BW i.v.) and blood samples were collected every 20 min for 4 h. Serum concentrations of LH and cortisol were determined by RIA. Mean serum concentrations of LH and cortisol were each similar ($P>.05$) in barrows the 4 h before administration of TKX (pre-TKX). Mean serum concentrations of LH decreased ($P<.05$) by 40 min post administration of TKX and remained less compared to pre-TKX for 180 min. Mean serum concentrations of cortisol increased ($P<.05$) within 20 min of administration of TKX and remained elevated compared to pre-TKX concentrations for 180 min. Mean serum concentrations of LH did not differ ($P>.05$) in gilts before and after administration of TKX. Mean serum concentrations of cortisol increased ($P<.05$) within 20 min of administration of TKX in gilts and remained elevated for 140 min. Mean serum concentrations of LH and cortisol were each similar ($P>.05$) within barrows and gilts before and after administration of PEN on d 8. Administration of TKX to barrows and gilts increased serum concentrations of cortisol but transient decreases in serum concentrations of LH were observed only in barrows. These data indicate that gonadal status may influence the ability of TKX to alter LH concentrations.

Key Words: Pigs, LH, Cortisol

247 Increasing the holding time of boar spermatozoa at 15^{o} C before freezing decreases fertility. H. David Guthrie* and G.R. Welch, *USDA , Beltsville Agricultural Research Center, Germplasm & Gamete Physiology Laboratory.*

An experiment was conducted to determine the effect of pre-freeze holding time and commercial extender type on boar spermatozoa viability

and fertility. One ejaculate from each of six boars was held in two commercial boar semen extenders, Beltsville Thawing Solution and Androhep Plus, for either 3 or 24 h at 15^o C to simulate overnight shipment, and then frozen in 0.5- and 5-mL straws. The spermatozoa thawed from the 5-mL straws were used for artificial insemination (AI) of 31 gilts and sows within 4 h before the expected time of ovulation induced by injection of 750 IU of hCG 130 h after the last feeding of Regu-Mate for estrus synchronization. The pregnancy rate 23 days after AI favored the 3 h compared to the 24 h holding time, 75 and 53%, respectively; but the difference was not significant. However, embryo number per animal and embryo survival percentage were decreased from 15 to 9 (p = 0.0305) and from 73 and 46% (p = 0.0015), respectively, as holding time at 15^o C increased from 3 to 24 h. Pre-freeze and post-thaw sperm motility, plasma membrane integrity, and acrosome morphology were of little value in predicting the decrease in sperm fertility after increasing holding time from 3 to 24 h. These results are important because they indicate that fertility of thawed sperm will be reduced after overnight shipping of liquid semen to another location before cryopreservation, under conditions in which sperm would be expected to remain fertile in liquid form.

Key Words: Cryopreservation, Swine, Embryo Survival

248 Timed artificial insemination of beef heifers using a 7-11/Co-synch protocol. A. W. Thompson*[1], C. D. Holladay, and D. M. Grieger[1], [1]*Kansas State University*.

Previous research has shown that an estrus synchronization program using a short period of feeding MGA in conjunction with a Co-synch protocol (7-11 Synch) was effective in synchronizing estrus in postpartum beef cows. The objective of this study was to test this synchronization protocol with yearling beef heifers in comparison to the Co-synch protocol using timed artificial insemination (A.I.). Fifty-eight commercial beef heifers from the Kansas State University Commercial Cow-Calf herd were used. Heifers were split into two groups; 28 heifers received the Co-synch protocol and 30 heifers were placed into the 7-11/Co-synch protocol. Beginning on day 1, heifers in the 7-11/Co-synch treatment were fed MGA (0.5mg/animal/d) individually for 7 days. On day 7, the last day of MGA feeding, heifers were injected with prostaglandin $F_2\alpha$ (PGF). On day 11, all 58 heifers were started on the Co-synch protocol by receiving an injection of GnRH (100mg). One week later on day 18, all heifers received an injection of PGF. On day 20, all heifers were given a shot of GnRH (100mg) and artificially inseminated by a single technician. Ultrasonography was used to determine pregnancy status 29 days post-breeding. A greater (p<.01) percentage of heifers were pregnant in the 7-11/Co-synch treatment (66%) as compared to the Co-synch treatment alone (31%). This study demonstrates the potential of using a short MGA feeding period prior to Co-synch treatment to obtain acceptable pregnancy rates using timed A.I. in beef heifers.

Key Words: Heifer, Timed AI, Synchronization

249 Comparison of long-term and short-term MGA-Select for estrus synchronization in beef cows. J.D. Arseneau*[1], M.C. Claeys[1], J.M. DeJarnette[2], and R.P. Lemenager[1], [1]*Purdue University, West Lafayette, IN, USA*, [2]*Select Sires, Inc., Plain City, OH, USA*.

Multiparous (n=100; 42.2 $\pm$ 10.4 d postpartum) and primiparous (n=44; 90.8 $\pm$ 10.1 d postpartum) suckled beef cows were used in a study to compare the efficacy of a long-term MGA-Select to a short-term MGA-Select estrus synchronization program. Cows were randomly assigned on d 0 by age and days postpartum to two treatments: 1) 0.5 $mg \cdot hd^{-1} \cdot d^{-1}$ MGA d 1 to 14; 86 μg GnRH d 26; 25 mg PGF2α d 33 (Long-MGA), or 2) 86 μg GnRH d 26; 0.5 $mg \cdot hd^{-1} \cdot d^{-1}$ MGA d 27 to 32; 25 mg PGF2α d 33 (Short-MGA). Cows observed in estrus following PGF2α were inseminated approximately 12 h later. All cows not detected in estrus were fixed-time inseminated 72 to 75 h after PGF2α, and given a second injection of GnRH at the time of insemination. Pregnancy diagnosis was determined by ultrasonography 40 d after insemination. Data were analyzed separately for multiparous and primiparous cows. A greater percentage of multiparous cows tended (P=0.07) to exhibit estrus following Short-MGA (54.0%) compared to Long-MGA (36.0%). There was not a statistical difference between treatments for percentage of primiparous cows detected in estrus following synchronization (22.7% and 31.8% for Long-MGA and Short-MGA, respectively). Similar pregnancy rates were obtained between treatments from insemination following detected estrus. However, pregnancy rates from fixed time inseminations were greater for Long-MGA than Short-MGA (Multiparous; 65.6% and 34.8%, P<0.02: Primiparous; 77.3% and 40.9%, P<0.01). Overall pregnancy rates to insemination (estrus and time inseminations) for multiparous cows were similar (P=0.30) between Long-MGA (68.0%) and Short-MGA (58.0%). A greater (P<0.01) percentage of primiparous cows conceived to insemination (estrus and time inseminations) following Long-MGA (77.3%) compared to Short-MGA (40.9%). In summary, although overall percentage of cows observed in estrus following synchronization was low in this study, a greater percentage of multiparous cows were detected in estrus following Short-term MGA-Select than Long-term MGA-Select. However, in a timed AI system, greater pregnancy rates were obtained from a 14 d MGA-Select regimen than a 6 d MGA-Select.

Key Words: Estrus Synchronization, MGA-Select, Beef Cows

250 Microarray analysis of gene expression in dominant ovarian follicles (DF) from heat stress (HS) and thermoneutral (TN) heifers. S.J. Kolath*[1], P.M. Coussens[2], S. Sipkovsky[2], S.J. Wilson[1], D.E. Spiers[1], J.N. Spain[1], and M.C. Lucy[1], [1]*University of Missouri*, [2]*Michigan State University*.

Heat stress decreases ovarian follicular growth and causes infertility in cattle. The objective was to compare gene expression in DF from heifers exposed to HS or TN environments. Estrous cycles were synchronized (estrus = d 0) in six Holstein heifers randomly assigned to HS (n=3) or TN (n=3) treatment. On d 5, heifers were moved into environmental chambers (19^{o}C). Beginning on d 10, the ambient temperature for HS heifers was increased 3^{o}C per day to 33^{o}C on d 14. Ambient temperature for TN heifers remained at 19^{o}C. Heat stress was coincident with the second follicular wave. On d 15, heifers were ovariectomized and the second wave DF was collected (diameter = 12.0$\pm$.7 mm). Messenger RNA was isolated, reverse transcribed into cDNA, and labeled with either Cy3 or Cy5 for the purpose of hybridization to the BOTL microarray (1277 genes) from the Center for Animal Functional Genomics (http://gowhite.ans.msu.edu). A dye reversal design was employed in which HS and TN heifers were paired (n=3 pairs). A total of six microarrays were analyzed. Fluorescence was measured and normalized using the GenePix 4000B scanner with GenePix Pro 4.0 software (Axon Instruments Inc., Union City, CA). Mean fluorescence intensity for each gene was analyzed for the effects of treatment, heifer(treatment), and replicate. Candidate genes had Cy5/Cy3 ratios that differed for HS and TN heifers (P<.05). Of the 35 candidate genes, 30 were increased in response to HS whereas 5 where decreased. Genes increased in HS heifers were transcription factors (TAF6, CEBPB, NFE2L2), DNA binding proteins (TOP3B, DZIP1), RNA binding proteins (GRSF1), and apoptosis-related factors (DAP, SIVA). Some transcription factors (LIM04, Tex27, KLF2) were decreased in HS heifers. DF respond to heat stress by down-regulating some transcription factors while up-regulating others. Up-regulation of transcription factors as well as DNA/RNA binding proteins may counteract apoptotic events caused by HS.

Key Words: Microarray, Ovary, Heat stress

251 Development of Pig Embryos in Culture Media Containing HEPES: Preliminary Results. J.N. Caamano*[1], G.M. Wu[1], T.C. McCauley[1], T.C Cantley[1], A.R. Rieke[1], J. Mao[1], R. Farwell[1], B.A. Didion[2], C. Murphy[1], and B.N. Day[1], [1]*Univeristy of Missouri, Columbia MO*, [2]*Monsanto, St. Louis, Mo*.

Recent advances in non-surgical embryo transfer in swine will require the development of a practical culture system that could be used under field conditions. The objective of this study was to assess the effect of culture medium containing HEPES in the development of pig embryos produced in vitro and in vivo. In Experiment 1, day 4 morulae produced in vitro (IVM/IVF/EC) were randomly allocated to 3 treatments and cultured for 48 hours. Embryos (n=10) were loaded into 0.25 ml straw (experimental unit) and placed in a portable incubator. Embryos were placed in TALP-HEPES-0.4% BSA (Group 1), modified NCSU-23 with reduced amount of NaHCO3 [2mM] and the addition of 10 mM HEPES (Group 2). As a control (group 3) , embryos were cultured in NCSU-23 under standard culture conditions (Nunc Dish, 5% CO2 in air). In Experiment 2, embryos collected from donor gilts on day 4 after the onset of estrus (4-cell embryos) were cultured in modified NCSU-23 in 0.25

ml straws (mNCSU-straw; n= 15) and in 1.5 ml microtubes (mNCSU-tubes; n= 15). A group of control embryos were cultured in NCSU-23 under standard culture conditions (n=11). Blastocyst formation and embryonic cell number were assessed in each experiment. Blastocyst formation rates and embryonic cell numbers were analyzed using SAS-GLM procedure. In Experiment 1, blastocyst formation rate was higher ($P<0.01$) in embryos cultured as controls NCSU-23 (69.0 $\pm$ 5.3 %) than in TALP-HEPES (33.4 $\pm$ 5.7 %) or mNCSU-HEPES (30.4 $\pm$ 5.3 %). Blastocyst cell numbers were also higher ($P<0.01$) in the control group than in the media containing HEPES. In Experiment 2, treatment did not ($P>0.64$) affect blastocyst formation rate, which was 90 $\pm$ 10.0 %, 90 $\pm$ 10.0 % and 100 $\pm$ 0.0 % for mNCSU-straw, mNCSU-tube and control, respectively. Embryonic cell numbers were higher ($P<0.01$) in embryos cultured in NCSU-23 (54.1 $\pm$ 2.1) than in the mNCSU in straws (32.9 $\pm$ 1.7) or microtubes (32.5 $\pm$ 1.7).

Key Words: Embryos, Culture Media, Swine

252 Endocrine responses to short-term feed deprivation in weanling pigs. B.E. Salfen* and J.A. Carroll, *Animal Physiology Research Unit, Agricultural Research Service-USDA, Columbia, Missouri.*

Our objective was to determine endocrine responses to a short-term (24 h) feed deprivation period in weaned pigs. Eight crossbred male pigs were weaned at 18 d of age and placed on a complex nursery diet. At 4 d post-weaning, pigs were non-surgically fitted with an indwelling jugular vein catheter. Pigs in the feed deprived group (FD; n=4) had feed removed 5 d post-weaning, and feed was returned 24 h later. Control pigs (Con; n=4) were allowed ad libitum access to feed. Blood samples were collected at 0 h, 6 h, 12 h, 24 h and 30 h for determination of ghrelin (GR) and IGF-I. Four sub-samples were collected at each time point at 15 min intervals. Body weights (BW) of pigs were determined at weaning, 21 d of age and after the 30 h time point (24 d of age). There was a time X treatment difference in BW ($P<0.05$). FD pigs gained less weight throughout the experiment than Con pigs (0.67 0.34 vs. 0.32 0.16 kg; $P<0.06$). There was no difference in serum GR or IGF-I among the four sub-samples ($P>0.90$), therefore the mean of the sub-samples were utilized for statistical analysis. Serum GR at T0 tended to be different between treatments ($P=0.06$), therefore GR concentrations of each pig at various time points were expressed relative to T0. There was a time X treatment effect on GR concentrations ($P<0.01$). Serum GR in FD pigs tended to decrease 12 h compared to Con pigs ($P=0.08$). Relative concentrations of GR increased from 12 h to 24 h ($P<0.01$) and remained elevated through the 30 h time point in the FD treatment, but remained unchanged at all time points in Con pigs ($P=0.91$). There was a time X treatment effect on IGF-I ($P<0.001$). Serum IGF-I fell throughout the experiment and was lower in FD pigs at 12 h, 24 h and 30 h compared to Con pigs ($P<0.05$). Serum IGF-I increased following the return of feed at 30 h compared to 24 h ($P<0.06$). IGF-I concentrations rose throughout the study period in Con pigs ($P<0.01$). These results indicate that serum GR and IGF-I are influenced by short-term feed deprivation in weanling pigs.

Key Words: Piglet, Food Deprivation, Weaning

253 A model for long term evaluation of bioavailability and activity of value added dietary components using fistulated, multiple catheterized pigs. C.F. Shipley*[1], M.V. Eberhardt, K.M. Clements, M.C. Black, H.Y.M. Elshire, M.E. Tumbleson, and V.L. Jarrell, [1]*University of Illinois, Urbana, Illinois.*

Added values from agricultural products open markets to consumers interested in improved health. Health claims associated with bioactive components cite little evidence of bioavailability, bioactivity or safety and efficacy. Our objective was to develop an animal model for evaluating dietary components over 10 or more weeks of exposure. We modified techniques independently used to collect total feces and urine, sample digesta cranial to the cecum and prior to microbial metabolism in the lower gut (fistulated distal ileum), sample metabolites from blood prior to hepatic processing (catheterization of the hepatic portal vein) and sample metabolites in systemic blood following delivery to tissues (catheterization of the jugular vein). Eight crossbred Yorkshire barrows, body weight = 24.5 +/-2.7 kg, were used. Nonsurvival surgeries were conducted on 2 animals at 22 and 20 kg body weight. Catheters were inserted 20 cm into the jugular vein. Catheters were inserted 35 cm via the mesenteric vein into the hepatic portal vein. Catheters were recovered and placement confirmed post mortem. Catheter lengths were then adjusted to 13 and 15 cm, respectively, prior to conducting survival procedures on the remaining animals. Six animals were housed in metabolic crates such that feed intake, total feces and urine could be assessed. A 2 week post surgical period allowing acclimation to purified diet was followed by a 10 week trial. Vascular catheters were flushed 2X daily and more frequently during timed sampling periods. Three of 6 catheters placed in hepatic portal veins were removed from live pigs at 28, 33 and 38 days post-surgery. These animals remained in the study to completion. The loss of hepatic portal catheters was attributed to breakdown of adhesive at mesh anchors and peristaltic action of the small intestine. All 9 of 12 remaining vascular catheters were patent to the end of the study at 77 to 83 days. All 6 fistulas remained patent. Animals had attained an average body weight of 100.4 +/- 5.4 kg with an average rate of gain of 0.93 +/- 0.07 kg/d. We conclude that fistulated, multiple catheterized pigs can be used to evaluate long term effects of dietary components.

Key Words: Bioavailability, Pigs, Dietary Components

254 Comparison of gravid uterine parameters in naturally bred ewes and ewes after transfer of *in vitro* produced embryos, and in single, twin and triplet pregnancies. D. Pant*, J.T. Choi, J.S. Luther, P. Borowicz, R.M. Weigl, J.D. Kirsch, K.C. Kraft, D.A. Redmer, L.P. Reynolds, and A.T. Grazul-Bilska, *North Dakota State University.*

Large offspring syndrome may be initiated in ovine embryos after exposure to *in vitro* conditions. Various parameters of the gravid uterus on day 140 after fertilization were compared: (i) in ewes (n=4) bred naturally, and in ewes (n=18) after transfer of *in vitro* produced embryos, and (ii) in single, twin and triplet pregnancies after transfer of *in vitro* produced embryos. On day 5 after *in vitro* fertilization, two to three embryos with 16 or more cells were transferred to recipient ewes that were at day 5 after estrus. On day 140 of pregnancy, the reproductive tract was collected from all ewes and the following parameters were determined: the number, sex and weight of fetuses, weight of uterus and fetal membranes, weight and numbers of placentomes. Weight of fetuses was similar for naturally bred ewes and ewes after embryo transfer (ET), but the weight of individual placentomes was greater ($P<0.05$) for ewes after ET (8.5$\pm$.5 g) than for naturally bred ewes (5.4$\pm$.9 g) and the total weight of placentomes/ewe tended to be greater ($P<0.1$) for ewes after ET (0.66$\pm$.05 kg) than for the naturally bred ewes (0.48$\pm$.03 kg). The number of placentomes/ewe was less ($P<0.01$) for single pregnancies (67.0$\pm$.2) than for twin (87.0$\pm$.1) or triplet (85.7$\pm$.7) pregnancies. The number of placentomes/fetus was greater ($P<0.01$) for single (67.0$\pm$.2), less for twin (43.5$\pm$.0) and least for triplet (28.5$\pm$.2) pregnancies. However, the weight of each individual placentome was greater ($P<0.06$) for triplet (11.2$\pm$.2 g) than for twin (8.3$\pm$8 g) or single (7.7$\pm$.5 g) pregnancies. For single, twin and triplet pregnancies, the number of fetuses per ewe was negatively correlated with the weight of placentomes/fetus (r^2 = -0.65; $P<0.003$), the number of placentomes/fetus (r^2 = -0.86; $P<0.001$) and the weight of the fetus (r^2 = -0.80; $P<0.001$), and positively correlated with the weight of individual placentome (r^2= +0.50; $P<0.03$). These data demonstrate the lack of LOS, indicating that culture conditions were optimal for production of ovine embryos. The low number of placentomes/fetus seen in multiple pregnancies appears to be compensated for by the increase in the total number of placentomes and the weight of each placentome.

Key Words: Large Offspring Syndrome, Ewe, In Vitro Fertilization

255 Impact of thermal environment and spray-dried plasma on the acute phase response of pigs challenged with lipopolysaccharide (LPS). J. W. Frank*[1], J. A. Carroll[2], G. L. Allee[1], and M. E. Zannelli[3], [1]*University of Missouri,* [2]*Animal Physiology Research Unit, Agricultural Research Service, USDA, Columbia, MO,* [3]*Simple Solutions, Attleboro, MA.*

Forty barrows (TR4 $\times$ C22) were weaned at 17 d of age (6.27 $\pm$ 0.30 kg) and housed 2 pigs/pen in a thermal neutral environment (TN: constant 26.7°C) and fed diets with or without 7% spray-dried plasma (SDP). On d 7, one pig/pen was moved into a cold environment (CE: constant 15.6°C). Pigs were fitted with jugular catheters on d 11. The following day, 16 pigs/environment (8 pigs/dietary treatment) were challenged

with 75 μg/kg of BW of LPS. Blood samples were collected over a 4.5-h period, then pigs were sacrificed for tissue sample collection. Pigs housed in the CE consumed more feed and had lower gain to feed ratios than pigs housed in TN from d 7 to 11 ($P < 0.001$). There were no environment by diet interactions from d 7 to 11 ($P > 0.78$). Basal serum ACTH and cortisol (CS) were lower in TN pigs compared to CE pigs ($P < 0.001$). Pigs fed diets without SDP had lower serum CS over the 4.5-h period compared to pigs fed SDP (time × diet, $P < 0.001$). Serum tumor necrosis factor-α were highest for pigs consuming SDP in the CE, while there were no differences among the other treatments (time × diet × environment, $P < 0.02$). Pigs housed in the CE had higher serum interleukin-1β (IL-1) and interleukin-6 (IL-6) compared to TN pigs ($P < 0.001$). Furthermore, pigs consuming SDP also had slightly higher serum IL-1 ($P < 0.10$) and significantly higher IL-6 compared to the pigs fed no SDP. Overall there were no consistent interactions between feeding SDP and thermal environment. Pigs consuming diets containing SDP and subsequently challenged with LPS responded with elevated serum concentrations of CS and cytokines compared to pigs fed diets with no SDP. Housing pigs in a CE increased the basal ACTH and CS, and when challenged with LPS resulted in elevated serum cytokines. Pigs consuming SDP and exposed to an endotoxin challenge that circumvents mucosal immune protection become immunologically hyper-responsive.

Key Words: Pigs, Cytokines, Spray-dried Plasma

256 Immune response in *Escherichicia coli* challenged pigs exhibiting a febrile response in absence of elevated TNF-α.

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The objective of this study was to determine the immune response in pigs challenged with *E. coli*. Twenty-two single sourced, 24-d old crossbred pigs (5.44 kg) were utilized. Pigs were individually housed, provided *ad libitum* feed and water, and assigned to blood collection (n=10) or rectal temperature measurement (n=12) groups. Blood collection pigs were non-surgically cannulated one day prior to blood collection. At 0 hr, all pigs received a 10 mL dose of 2.4 x 10^8 colony-forming units of *E. coli* K88 via a nasogastric tube. Blood collection and rectal temperature monitoring occurred hourly from -1 to 5 hr post-*E. coli*, every 30 minutes from 5 to 8 hrs, and at 24 hrs post-*E. coli*. Serum concentrations of cortisol (CS), interferon-γ (IFN), tumor necrosis factor-α (TNF), interleukin-1β (IL-1), interleukin-6 (IL-6), serum amyloid A (SAA), C-reactive protein (CRP), haptoglobin (HG), and lipopolysaccharide (LPS) were measured. After *E. coli* administration, CS, IFN, IL-1, IL-6, SAA, CRP, HG ($P < 0.0001$), and LPS ($P < 0.002$) increased. Peak concentrations of CS and IL-6 occurred at 4 hr post-*E. coli*, IFN and rectal temperature peaked at 5.5 hr post-*E. coli*, and IL-1 peaked at 6 hr post-*E. coli*. Serum concentrations of TNF were undetectable throughout the sampling period. The greatest circulating concentrations of LPS were detected at 7.5 hr post-*E. coli*, and the acute phase proteins CRP, HG, and SAA were still increasing at 24 hr post-*E. coli*. While TNF was not associated with increased rectal temperature, positive correlations existed between rectal temperature and CS ($r = .49$; $P < 0.0001$), IFN ($r = .29$; $P < 0.0009$), IL-1 ($r = .45$; 0.0001), IL-6 ($r = .31$; $P < 0.0003$), and LPS ($r = .29$; $P < 0.0009$). These data indicate that circulating TNF does not play an integral role in initiating the febrile response in pigs challenged with *E. coli*; but that CS, IL-6, or IFN may act as endogenous pyrogens.

Key Words: *E. coli*, Cytokines, Acute Phase Proteins

257 Factors affecting temporal characteristics of estrus and ovulation on commercial sow farms.

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Elucidation of factors that affect estrus and ovulation characteristics may allow refinement of artificial insemination protocols and increased reproductive efficiency. Our objective was to examine the effects of season (spring, summer), genotype (A, B, C, D), parity (1, 2, 3, $\geq$ 4), lactation length ($\leq$ 13, 14 to 15, 16 to 17, 18 to 19, $\geq$ 20 d), and weaning-to-estrus interval (WEI; 3, 4, 5, 6, $\geq$ 7 d) on duration of estrus (DE) and onset of estrus-to-ovulation interval (EOI) in three sow farms. DE and EOI were estimated via boar exposure and transabdominal real-time ultrasonography, respectively, every 6 h from 2 to 10 d postweaning in 533 sows (89/season). Sows weaned in the spring (March, April) compared to the summer (July, August) had a shorter DE on farms 1 (52.7 vs. 60.5 h; $P < .001$) and 3 (47.3 vs. 55.8 h; $P < .001$) but only tended to have a shorter DE on farm 2 (52.1 vs. 54.5 h; $P < .10$). Similarly, EOI was shorter for sows weaned in the spring compared to the summer on farms 1 (37.9 vs. 48.1 h; $P < .001$) and 3 (35.4 vs. 42.7 h; $P < .001$) but not on farm 2 (38.1 vs. 40.4 h; $P > .11$). Multiple genotypes were only present on farms 1 (A, B, C) and 3 (C, D). DE was not different between genotypes on farms 1 or 3 ($P > .14$) but EOI was shorter for genotype B compared to either A or C on farm 1 (39.6 vs. 44.8 or 44.3 h; $P < .04$). Even after correction for differences in WEI between the parity classes, parity 1 sows tended to have a shorter DE and had a shorter EOI than sows $\geq$ 4 parities (52.3 vs. 54.6 h; $P < .07$ and 38.7 vs. 42.8 h; $P < .002$, respectively). As lactation length increased there tended to be a linear decrease of DE (56.2, 56.3, 54.0, 53.3, 52.9 h; $P < .08$) and EOI (43.7, 41.4, 40.4, 40.5, 39.4 h; $P < .09$). As WEI increased there was a linear decrease of DE (64.4, 57.5, 52.8, 49.7, 44.8 h; $P < .001$) and EOI (48.6, 44.1, 40.4, 37.1, 32.0 h; $P < .001$). These data suggest that in addition to weaning-to-estrus interval, season in particular can have a substantial affect on duration of estrus and time of ovulation within and between farms.

Key Words: Estrus, Ovulation, Sow

258 Ovarian follicular populations before weaning in sows are dependent on FSH.

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The factors affecting follicular growth and the variation in weaning to estrus and weaning to ovulation intervals in sows are poorly understood. The objective was to determine if follicular populations before weaning in sows are dependent on FSH. The posterior vena cava anterior to the ovarian vein was cannulated in 20 sows at 12 3.0 d after farrowing. Sows were randomly assigned to receive either 30 mL of charcoal extracted follicular fluid (FF, n=9) or 30 mL saline (n=11) thrice daily (0700, 1500, and 2300 h) for 96 hours beginning at 14 ± 3 d after farrowing. Sows were weaned 48 h after the last infusion. Blood samples were collected thrice daily beginning on the day of cannulation and continuing until ovulation. Serum FSH concentrations were measured by radioimmunoassay. Average follicular diameter was determined once daily by transrectal ultrasonography. Sows treated with FF had longer ($P < 0.05$) weaning to estrus (6.1 ± 0.4 d) and weaning to ovulation (8.6 ± 0.5 d) intervals compared to saline treated sows (4.7 ± 0.4 d and 7.2 ± 0.4 d, respectively). A treatment by time effect was detected for serum FSH ($P < 0.001$) and follicular diameter ($P < 0.001$). Serum FSH concentrations and follicular diameter decreased in FF sows during the infusion period. After the infusion period serum FSH concentrations rebounded in FF sows and follicles resumed growth but failed to achieve equivalent diameters compared to control sows after weaning. We conclude that follicular growth in lactating sows is FSH-dependent before weaning and that suppressing follicular growth before weaning decreases size of follicles after weaning and increases intervals to estrus and ovulation.

	FSH ng/mL∗		Diameter (mm)∗	
Hour	FF	Saline	FF	Saline
-184	14.4 ± 2.1	13.8 ± 2.0		
-144[a]	12.8 ± 2.1	13.0 ± 1.9	2.8 ± 0.2	2.5 ± 0.2
-48[b]	3.1 ± 2.1	11.4 ± 1.9	1.0 ± 0.2	2.5 ± 0.2
0[c]	23.7 ± 2.3	12.3 ± 1.9	1.2 ± 0.2	2.9 ± 0.2
48	27.0 ± 2.3	14.6 ± 1.9	3.0 ± 0.2	3.9 ± 0.2
72	8.2 ± 2.3	7.7 ± 1.9	3.6 ± 0.2	4.5 ± 0.2
168	8.1 ± 2.4	7.8 ± 2.6	5.8 ± 0.2	6.7 ± 0.2

∗lsmeans SEM [a]start of infusion, [b]end of infusion, [c]day of weaning

Key Words: FSH, Follicle, Lactating Sows

259 Effect of PG600 and adjusted mating times on reproduction performance in weaned sows.

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Sows administered PG600 at weaning average > 91% return to estrus within a week, however farrowing rate is often not improved. Since weaning to estrus interval (WEI) influences estrus to ovulation interval (EOV) and PG600 alters WEI, lowered reproductive performance may result since standard mating times may be less than optimal. This

study evaluated the effect of adjusted breeding times based on WEI and predicted EOV following PG600. All sows were given PG600 at weaning and allotted by genetics, parity, lactation length, and P2 backfat to adjusted (A, n = 43) or control (C, n = 43) mating times. Adjusted breeding involved: 1) 2-3 d WEI, AI at 36 and 48 h, 2) 4 d WEI, AI at 24 and 36 h, 3) 5 d WEI, AI at 12 and 24 h, and 4) 6-7 d WEI, AI at 0 and 12 h. Controls were AI at 0 and 24 h after onset of estrus. Estrous detection was performed twice daily for 7 d following PG600 and transrectal ultrasound was performed twice daily from onset of estrus until time of ovulation. There was no effect of treatment on return to estrus or ovulation (93.0 %) within 7 d of weaning. The EOV was influenced by WEI ($P < 0.001$) and tended ($P = 0.06$) to be longer for A (41.9 h) vs C (37.9 h). The percent of first AI occurring within 24 h before ovulation (73.3 vs 50.0%) was improved ($P < 0.05$) and closer to ovulation for A (-23 h) compared to C (-31h). Treatment did not affect the percent of second AI occurring within 24 h of ovulation but tended ($P < 0.06$) to influence the interval for the second AI to ovulation for A (-6.9 h) compared to C (-13.1 h). Treatment did not affect the overall percent of sows AI within 24 h before ovulation for A (98.9%) or C (91.3%). Treatment did not influence conception (87.8%) or farrowing (77.5%) rates or total pigs born (10.8). In conclusion, while AI times for C appear optimal for sows returning to estrus at 4-5 d, the A treatment tended (P=0.1) to have advantages over C at 2-3 d for first AI and at 6-7 d ($P < 0.05$) for second AI. However, farrowing data suggests a treatment x WEI interaction ($P = 0.13$) with AI times for C optimal at WEI 3-5 d, but not for 6-7 d. Control AI times may be optimal for early returning sows, but for late returning sows.

Key Words: Estrus, Ovulation, Breeding

260 Evaluation of pFSH and pLH on estrus induction and ovulation in prepubertal gilts. A.L. Jackson*[1] and R.V. Knox[1], [1] *University of Illinois Urbana-Champaign, IL.*

Increasing numbers of healthy embryos has important implications for efficiency of reproductive technologies. These studies investigated the ability of porcine FSH (pFSH) to induce estrus and ovulation in prepubertal gilts. In study 1, gilts (n=92) 176 d of age and 109 kg were randomly assigned in a 2 x 3 factorial treatment design to receive a total of 10 or 15 Armour units (AU) of pFSH containing 6, 10, or 15% pLH. Gilts received 2.5-cc injections of $1/6^{th}$ the amount of pFSH, given s.c. at 8-h intervals for two days. Control gilts (n=15) received s.c. PG600. In study 2, gilts received 15 AU pFSH, 10% LH in polyvinylpyrrolidone (PVP), s.c. either a single 10-cc injection (1P, n=16) or two 10-cc injections (2P, n=12). Control (n=12) received s.c. PG600. Estrus detection occurred twice daily with a mature boar. In study 1, estrus induction tended ($P = 0.01$) to be influenced by treatment, lowest for 15-15 (31%) and highest for 15-10 (77%) compared to PG600 (60%). Ovulation also tended ($P = 0.12$) to be influenced by treatment, lowest for 10-15 (24%) and highest for 15-10 (80%) compared to PG600 (76%). Number of corpora lutea (CL) was influenced ($P < 0.001$) by treatment, lowest for 10-15 (1.4) and highest for 15-10 (31) compared to PG600 (19). There was no treatment effect on cyst frequency compared to PG600. In study 2, estrus tended ($P < 0.02$) to be influenced by treatment, lowest for 1P (44%) and highest for 2P (54%) compared to PG600 (95%). Ovulation tended ($P < 0.0001$) to be influenced by treatment, lowest for 1P (33%) and highest for 2P (95%) compared to PG600 (100%). CL number was influenced ($P < 0.005$) by treatment, lowest for 1P (2.0) and highest for 2P (26.6) compared to PG600 (15.4). Treatment did not affect cysts. Results indicate that dose and percent LH content of pFSH tends to influence estrus and ovulation, but clearly affects CL number. Results also suggest that compared to PG600, the 15-10 regimen produced analogous estrus and ovulatory results. For single and double pFSH administration using PVP, the 2P treatment appears promising and comparable to PG600.

Key Words: FHS, Pigs, Estrus

261 A polymorphism in the pig erythropoietin receptor (EPOR) gene is associated with uterine capacity. J.L. Vallet*, B.A. Freking, K.A. Leymaster, and R.K. Christenson, *USDA, ARS, Roman L. Hruska U.S. Meat Animal Research Center.*

Selection for uterine capacity increased fetal hematocrits measured on d 105 of gestation. We hypothesized that this increase might be partially due to polymorphism(s) in the EPOR gene. The likely positions of the introns were predicted within the porcine EPOR gene by comparing the porcine EPOR cDNA to the human EPOR gene. Oligonucleotide primers based on the porcine cDNA were designed to amplify by PCR a region of the porcine EPOR gene that was likely to contain two moderately sized introns. The genomic DNA from 96 gilts from populations available at the Meat Animal Research Center (including 24 half Meishan, half white crossbred gilts, 24 gilts from lines selected either at random (CO), for ovulation rate (OR) or for uterine capacity (UC); and 48 pigs from other populations) were amplified by PCR using these primers, and the products were sequenced. The sequences were aligned and polymorphisms were identified. A genotyping assay for a C/T polymorphism in one of the introns was developed based on primer extension and mass spectrometry using Sequenom technology. This assay was used to genotype 212 gilts from the CO, OR and UC lines. The gilts had been unilaterally hysterectomized-ovariectomized, mated, and then slaughtered at 105 d of gestation. At slaughter, number of corpora lutea (CL) and litter size (a measure of uterine capacity) were recorded. Fetal and placental weights were also recorded, and a blood sample was collected from each fetus. Blood samples were measured for hematocrit and fetal plasma iron. Gilts were either homozygous CC or heterozygous CT, no TT gilts were observed. Litter size was greater ($P<0.01$) in CT gilts (8.3±0.5, n=21) compared to CC gilts (6.9±0.2, n=191). CL number (15.1±0.6,15.2±0.2), fetal weight (778±33, 800±11), placental weight (174±11, 189±4), fetal hematocrit (36.9±0.6, 36.8±0.2) and fetal plasma iron (1.17±0.05, 1.20±0.02) did not differ between CT and CC genotypes, respectively. These results suggest that variation within the EPOR gene or another nearby gene is associated with differences in uterine capacity, but this effect is not mediated by changes in hematocrit, placental or fetal weights, CL number or fetal plasma iron.

Key Words: Swine, Erythropoietin, Pregnancy

262 Are ovariectomized heifers an appropriate model to study the fundamental nature of the estrus event in cattle? C.R. Burke*[1,2], M.L. Mussard[1], and M.L. Day[1], [1] *The Ohio State University, Columbus OH,* [2] *Dexcel Research Ltd, Hamilton, New Zealand.*

The objectives were to determine: 1) if estradiol-induced estrus in ovariectomized (OVX) heifers is characteristically similar to that in ovarian-intact heifers, and: 2) if prior treatment with progesterone influences the nature of behavioral estrus in OVX heifers treated with estradiol. The rationale was that the OVX animal model would allow greater systematic control and convenience in the study of fundamental aspects underlying the signal for behavioral estrus in cattle. The 23 OVX beef heifers used in the present study had not been treated with progesterone since ovariectomy (339 ± 2 d). These animals received an intravaginal progesterone insert (CIDR) for six days (P4; n = 13) or were not treated with progesterone (NoP4; n = 12), and all received 0.5 mg estradiol benzoate (EB) i.m. 24 h after removal of the CIDR insert (equivalent time in the NoP4 treatment). Additionally, estrus was synchronized in ovarian-intact (INT; n = 6) heifers to coincide with the time of estrus in the OVX animals. Estrus was monitored using an electronic surveillance system (HeatWatch, DDx Inc.) with an estrus event being defined as ≥4 mounts lasting ≥1 s within a 4 h period. All INT heifers had an estrus event characterized with 55.3 ± 24.7 mounts lasting 1.7 ± 0.1 s at intervals of 29.5 ± 5.4 min over a duration of 15.5 ± 2.4 h. None of these variables were different between the INT and P4 treatments. However, among the OVX heifers, P4 treatment increased the incidence (13/13 vs 9/12; $P = 0.09$), number of mounts (47.8 ± 8.1 vs 20.4 ± 4.8; $P < 0.01$) and duration (13.3 ± 1.2 h vs 9.7 ± 1.3 h; $P = 0.07$), but not the interval from EB to onset of estrus (18.6 ± 0.6 h) as compared with the NoP4 treatment. The results show that behavioral characteristics of estrus in OVX heifers treated appropriately with progesterone and estradiol are not different than the spontaneous event in ovarian-intact heifers. In this regard, OVX heifers would appear to be a valid animal model to study the fundamental nature of behavioral estrus in cattle.

Key Words: Estrus Behavior, Progesterone, Ovarictomized Cattle

263 Recombinant oleptin prevents fasting-mediated reductions in pulsatile LH release and stimulates GH secretion in peripubertal heifers. M. Maciel[1,2,3], D. Zieba[2,3], M. Amstalden[2,3], D. Keisler[4], J. Neves[1], and G. Williams*[2,3], [1]*Federal University of Santa Maria, Santa Maria, Brazil,* [2]*Texas A&M University Agricultural Research Station, Beeville, TX,* [3]*Texas A&M University, College Station, TX,* [4]*University of Missouri, Columbia, MO.*

Short-term fasting suppresses the pulsatile secretion of LH in several animal models, including the peripubertal heifer. Moreover, studies in monogastric species and in one ruminant model (E_2-implanted wether) have shown that leptin treatment prevents this effect. Under similar feeding conditions, leptin has also been shown to stimulate GH secretion. Studies reported herein utilized the intact, peripubertal heifer, fasted for 72 h, to determine if exogenous leptin could 1) prevent a fasting-induced reduction in pulsatile LH secretion, 2) modify GnRH-mediated LH release, and 3) stimulate GH secretion. Thirteen Brahman x Hereford heifers (13.5-16 mo; 280-350 kg) were used. Heifers were assigned randomly to two groups: 1) Control (n=6); sc injections of saline and 2) Leptin (n=7); sc injections of oleptin (19.2 ug/kg) at 12-h intervals. At the end of a 6-h blood sampling period on D 3, heifers received iv a physiological (0.0011 ug/kg) pulse, followed 90 min later by a pharmacological (0.22 ug/ml) dose of GnRH, with additional blood samples collected for 5.5 h. Plasma concentrations of leptin were greater ($P = 0.0003$) throughout the experiment in the Leptin compared to the Control group (28.5±2.2 vs 4.5±0.2 ng/mL). Fasting caused a marked decline ($P = 0.004$) between D 0 and 3 in the frequency of LH pulses in controls (4.7±0.2 vs 2.8±0.3 pulses/6h). However, this effect was attenuated by leptin, with pulse frequency in the Leptin group increasing ($P < 0.008$) from D 0 to 3 (3.1±0.6 vs 4.4±0.5 pulses/6h) and greater ($P < 0.005$) than controls on D 3. Leptin had no effect on GnRH-induced LH release. However, plasma concentrations of GH were greater ($P = 0.001$) in leptin-treated heifers compared to controls on day 3. Fasting-mediated declines ($P < 0.002$) in circulating insulin and IGF-1 were observed in both groups, and were unaffected by leptin treatment. Results indicate, for the first time, the ability of exogenous leptin to prevent fasting-mediated reductions in LH pulse frequency and to increase GH secretion in the intact heifer. (USDA-NRI00-35203-9132;CAPES)

Key Words: Leptin, LH, Heifer

264 Effects of chronic administration of recombinant oleptin on LH secretion, metabolic hormones, and timing of puberty in growing beef heifers. M. Maciel[1,2,3], D. Zieba[2,3], M. Amstalden[2,3], D. Keisler[4], J. Neves[1], and G. Williams*[2,3], [1]*Federal University of Santa Maria, Santa Maria, Brazil,* [2]*Texas A&M University Agricultural Research Station, Beeville, TX,* [3]*Texas A&M University, College Station, TX,* [4]*University of Missouri, Columbia, MO.*

Circulating concentrations of leptin have been shown to increase during pubertal development. In beef heifers, serum concentrations of leptin increased linearly from 16 wk before until the wk of pubertal ovulation. Moreover, leptin treatment accelerates pubertal development in rodents. To test the hypothesis that exogenous leptin can hasten the onset of puberty in heifers, we examined the effects of recombinant oleptin on timing of puberty, pulsatile and GnRH-mediated LH release, and plasma concentrations of GH, IGF-1, and insulin. Fourteen fall-born, prepubertal heifers (Brahman x Hereford, 12-13 mo; 290-310 kg) were used. Heifers were stratified by age and BW and assigned randomly to two groups (7 animals/group): 1) Control; heifers received sc injections of saline 2x daily at 12-h intervals for 40 d, and 2) Leptin; heifers received sc injections of oleptin (19.2 ug/kg) 2x daily at 12-h intervals for 40 d. Blood samples were collected at 10-min intervals for 5 h on days 0, 5, 10, 20, 30 and 40, and 2x daily throughout the study. On day 41, heifers received iv injections of GnRH at 0 (0.0011 ug/kg) and 90 min (0.22 ug/kg), with additional sampling for 5.5 h. Diets promoted a gain of 0.32 0.09 kg/d and did not differ between groups ($P > 0.5$). Plasma concentrations of leptin increased markedly in leptin-treated heifers and were greater ($P < 0.0001$) than controls throughout (27.8 0.8 vs 4.9 0.12 ng/mL). None of the heifers reached puberty during the experiment. Mean concentrations of plasma LH, GH, IGF-1, and insulin were not affected by treatment ($P > 0.1$), nor was there an overall effect on the frequency of LH pulses ($P > 0.16$). However, a treatment x day interaction ($P = 0.02$) revealed that frequency of LH pulses (pulses/5h) was greater ($P = 0.03$) in controls (3.6 0.36) than in leptin-treated heifers (1.7 0.28) on day 10. Characteristics of GnRH-induced release of LH were not affected by treatment. In summary, leptin failed to alter the timing of puberty or endocrine characteristics in heifers under the conditions of this experiment. (USDA-NRI 00-35203-9132 and CAPES)

Key Words: Leptin, Puberty, Heifer

265 Effects of fat supplementation on reproductive parameters of beef heifers fed endophyte- infected fescue seed. J. D. Rhinehart*, E. S. Vanzant, J. D. Bailey, A. M. Arnett, E. Myers, K. K. Schillo, and L. H. Anderson, *University of Kentucky.*

This experiment was designed to characterize reproductive responses of beef heifers fed endophyte-infected fescue seed (E+) and to evaluate effects of fat supplementation on those responses. Sixteen pubertal crossbred heifers (BW = 414 kg) were randomly assigned to silage-based diets supplemented with endophyte-free fescue seed (E-, 60% of diet), endophyte-infected fescue seed (E+, 60% of diet) , or E+ with soybean oil (E+/Fat, 60% and 4.5% of diet, respectively). Diets provided similar amounts of energy and protein. During a 27-d adjustment period on respective diets, estrus was synchronized using two injections of prostaglandin $F_2\alpha$. Rectal temperature and jugular blood samples were collected daily throughout the study. Starting 12 hours prior to expected estrus, jugular blood samples were collected every two hours until ovulation. Heifers were observed for behavioral estrus four times daily. Beginning at the time of estrus, follicular dynamics were recorded every six hours, via transrectal ultrasonography, until ovulation. Rectal temperatures differed ($P < 0.08$) slightly early in the experiment but no differences occurred ($P > 0.20$) from day 7 (d0 = day of initial estrus) to completion (treatment x sampling day $P < 0.01$). Estrous cycle length was shorter ($P = 0.01$) in E+ (18.7 d) than in E- (21.6 d), but E+/Fat (20.0 d) was intermediate and similar to ($P > 0.16$) E+ and E-. Treatments did not affect the time from estrus to ovulation ($P = 0.20$) or from LH surge to ovulation ($P = 0.50$). Serum prolactin concentrations were greater ($P < 0.01$) for E- (238 ng/ml) than for E+ (158 ng/ml) or E+/Fat (151 ng/ml), which were similar ($P = 0.82$). Average daily gain was negative for all groups and was not affected by treatment ($P = 0.28$). We conclude that lower fertility in beef heifers grazing endophyte-infected fescue may be related to shortened estrous cycles. Fat supplementation did not appear to overcome the effects of endophyte.

Key Words: Endophyte, Fertility, Fat Supplementation

266 Effects of temperature-humidity index on pregnancy rate in beef cattle. J. L. Amundson*[1], T. L. Mader[1], and R. J. Rasby[1], [1]*University of Nebraska-Lincoln.*

Cows exposed to adverse weather during the breeding season are assumed to have decreased fertility and pregnancy rates. The objective of this study was to quantify the effect of temperature-humidity index (THI) on pregnancy rate (PR) of cattle. Eleven years of breeding data were examined from a herd of commercial, *Bos taurus*, crossbred cows (n∼180/y) from the University of Nebraska Dalbey-Hallack Research Farm in Virginia, Nebraska. Data included cow number, calf identification, calf sex, and calving date. All cows were bred by natural service, beginning in late-May, with a typical breeding season of 60 to 75 days. The bull to female ratio was approximately 1:25. Spring calving dates were recorded and used to calculate approximate breeding date. For standardization purposes, gestation length was 283 days in length. Relationships were determined between the proportion of cows bred in the first 30 days of the breeding season and mean temperature and THI during those 30 days. Weather data were compiled from the Great Plains Climate Center Weather Archives for a weather station located approximately 20 km from the research site. Average daily temperature and relative humidity were used to calculate daily THI for determining average THI for the first 30 days of the breeding period. The mean 30-day temperature and THI were 20.0 °C and 66.3, respectively. The change in PR, in the first 30 days of breeding, based on the entire breeding season or only the first 60 days were found to be -1.5% (R^2=0.30;P<0.1) and -1.6% (R^2=0.47;P<0.05), respectively, per °C increase in mean temperature, and -1.1% (R^2=0.33;P<0.1) and -1.1% (R^2=0.49;P<0.05), respectively, per unit increase in mean THI. Preliminary analysis indicated a PR threshold existed at THI=65. For the six years THI > 65, the change in 30-day PR, based on the entire breeding season or only the first 60 days were found to be -2.1% (R^2=0.53;P<0.1) and -1.8% (R^2=0.72;P<0.05), respectively, per °C increase in mean temperature, and -1.6% (R^2=0.64;P<0.06) and -1.4%

(R^2=0.81;P<0.05), respectively, per unit increase in mean THI above 65. For the five years THI<65 slopes were not significant and R^2 were less than .12. Within a 30-day period, PR declines 1.4 to 1.6% for each unit increase in mean THI above 65.

Key Words: Beef Cattle, Pregnancy Rate, Heat Stress

267 Pregnancy status of beef heifers immunized against luteinizing hormone and luteinizing hormone-releasing hormone.

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Immunization against reproductive hormones is a promising method of preventing heifers from entering the feedlot pregnant due to accidental bull exposure. Previous studies have successfully vaccinated against luteinizing hormone (LH) and luteinizing hormone-releasing hormone (LHRH) by linking these hormones to carrier proteins. The objective of this study was to develop a vaccine against LHRH and/or the β subunit of bovine LH (LHβ) using recombinant DNA methods. Glutathione-S-transferase (GST) coded for by the commercial expression vector pGEX-4T-3 (Pharmacia), served as the antigen of the control group, as well as the carrier protein for the three test groups. Three plasmids were constructed to encode for recombinant fusion proteins GST-LHβ, GST-LHRH, and GST-LHRH-LHβ. Protein was produced by a bacterial expression system and purified by GST affinity columns. Twenty yearling beef heifers were immunized against GST (n=5), GST-LHβ (n=5), GST-LHRH (n=5) or GST-LHRH-LHβ (n=5). Three injections were given at two-week intervals with an equal volume of Freund's complete adjuvant for the primary immunization and Freund's incomplete adjuvant for both booster immunizations. A fertile bull was placed with the heifers one week after the final immunization. Pregnancy status was determined using rectal palpation and ultrasonography 15 weeks after first bull exposure. The pregnancy rate of heifers immunized against LHRH (20%) was reduced when compared to the other treatment groups (p=0.01). All 5 heifers in the GST and GST-LHβ were pregnant compared to only 2 of 5 in the GST-LHRH-LHβ and 1 of 5 in the GST-LHRH treatment groups. Of the four nonpregnant heifers in the LHRH immunized group, three possessed infantile reproductive tracts. This study suggests that the combination of immunizing against both LH and LHRH was not more effective than LHRH alone, however, the recombinant LHRH treatment could have potential as a sterilization vaccine.

Key Words: LHRH, Immunization, Heifer

268 A timed artificial insemination (TAI) protocol for synchronizing two inseminations within a 32-d period in dairy cows and heifers.

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An estrous synchronization TAI protocol (PGPG with rapid resynchronization) that enables TAI of first and second (repeat service in cattle diagnosed nonpregnant) inseminations was tested in Holstein dairy cows (Exp. 1; n=80) and heifers (Exp. 2; n=51). The PGPG cattle were treated as follows: $PGF_{2\alpha}$ (25 mg Lutalyse), 3 d, GnRH (100 μg Cystorelin), 8 d, $PGF_{2\alpha}$, 2 d, GnRH, 4 h (heifers) or 8 h (cows), TAI. Control (PP) cattle were injected with $PGF_{2\alpha}$ as above but were injected with saline (2 ml) in place of GnRH and were AI following estrus after the second $PGF_{2\alpha}$. Blood for progesterone analysis was collected immediately before each injection. Pregnancy was detected by ultrasonography 30 d after AI. Dairy cows (Exp. 1) treated with PGPG had greater insemination rates [IR; 36/36 (100%); P<.001], equivalent conception rates [CR; 14/36 (39%)], and greater pregnancy rates [PR; 14/36 (39%); P<.01] compared to PP cows [15/44 (34%), 4/15 (27%), and 4/44 (9%), respectively]. Heifers (Exp. 2) treated with PGPG had greater IR [26/26 (100%); P<.05], and equivalent CR [16/26 (62%)], and PR [16/26 (62%)] compared to PP heifers [21/25 (84%), 11/21 (52%), and 11/25 (44%), respectively]. Conception rates for cows and heifers with luteolysis after the second $PGF_{2\alpha}$ were greater for PGPG compared to PP [27/41 (66%) and 9/25 (36%); PGPG and PP, respectively; P<.05]. The PGPG cows (n = 34) and heifers (n=8) diagnosed nonpregnant at 30-d pregnancy exam underwent rapid resynchronization TAI [$PGF_{2\alpha}$, 2 d, GnRH, 4 h (heifers) or 8 h (cows), TAI]. Pregnancy rates for cows and heifers after rapid resynchronization TAI [11/34 (32%) and 5/8 (63%), respectively] were similar to first TAI. We conclude that PGPG is a TAI protocol that can be used in dairy cows and heifers that achieves greater (cows) or equivalent (heifers) pregnancy rates compared to PP and AI at estrus. Cows and heifers treated with PGPG and diagnosed nonpregnant can be resynchronized and TAI within 2 d after a 30-d pregnancy exam.

Key Words: Estrous Synchronization, Dairy, AI

269 Season of calving and parity/s effects on milk production and reproductive factors in Holstein dairy cattle.

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The actual amount of milk produced during the lactation period is affected by several factors: 1) Breed 2) Parity 3) Season of calving 4) Geographic region 5) Management factors (nutrition, frequency of milking). In this study, we tried to determine the effect of parity and season of calving on milk production (305days) and reproductive factors such as open days (OD), Days in milk (DIM), Conception rate (CR) and calving interval (CI). This study was carried out in the Dasht dairy farm (2000 head), which is located in the northeast of Iran (Neyshabour city) and had an acceptable and computerized record keeping system between the years 1992-2001. TMR diet of milking cows was calculated according to the NRC1989 and the cows were milked three times a day (3X) in regular intervals. General linear models procedures of SAS v6.12 were used for ANOVA to evaluate differences among experimental groups. The design was completely randomized (unequal replicates). Means were compared using the Duncan test. Milk production($P\leq0.05$) and OD ($P\leq0.01$) were significant and reduced from spring to summer and then increased to autumn and winter. There were no significant effects on CR, CI and DIM in different seasons. Milk production increased significantly to fifth lactation and then decreased and OD decreased with lactation number ($P\leq0.01$). DIM and CR were significantly different between lactation numbers ($P\leq0.01$). CI was significantly affected by lactation number($P\leq0.05$).

Table1: Mean of different variables altered by season of calving or parity

	L1	L2	L3	L4	L5	>L6
Milk305(kg)	7069^{c}	7574^{bc}	7796^{b}	8098^{ab}	8522^{a}	8087^{ab}
OD (Days)	105^{a}	104^{ab}	101^{ab}	99^{abc}	97^{bc}	92^{c}
DIM (Days)	329^{ab}	314^{b}	308^{b}	333^{ab}	352^{a}	310^{b}
CR (Doses)	1.85^{bc}	1.79^{c}	1.86^{bc}	2.02^{abc}	2.18^{a}	2.08^{ab}
CI (Days)	387^{ab}	371^{b}	373^{b}	382^{ab}	389^{ab}	405^{a}

	Spring	Summer	Autumn	Winter
Milk305(kg)	7827^{a}	7379^{b}	7519^{ab}	7613^{ab}
OD (Days)	100^{bc}	97^{c}	104^{ab}	106^{a}
DIM (Days)	316^{a}	315^{a}	324^{a}	321^{a}
CR (Doses)	1.88^{a}	1.91^{a}	1.91^{a}	1.92^{a}
CI (Days)	3755^{a}	380^{a}	383^{a}	385^{a}

P Values of the superscripts are as the same in the text, L: Lactation number

Key Words: Season of Calving and Reproduction, Parity, Dairy cattle

270 Effects of serotonin agonist on the plasma concentrations of growth hormone, thyroid hormones and milk compositions and production in Holstein dairy cows.

R. Nasser Eslami* and H. Khazali, *Agricultural College of Tarbiat Modarres University, Tehran-Iran*.

Serotonin is one of the most important neurotransmitters in central nervous system, which can affect the function of hypothalamus. This experiment was conducted to evaluate the effects of intrajugular injection of serotonin agonist (L-Tryptophan) on plasma growth hormone (GH), triiodothyronine (T_3) and thyroxin (T_4) concentrations and milk yield and compositions. Twelve multiparous Holstein dairy cows were assigned randomly to four groups in split-plot design with three 5 d periods. After a five-days pretreatment period each group received one the treatments for five consecutive days. Treatments were: 1) saline (control) 2) 2 μg/kg BW 3) 4 μg/kg BW 4) 8 μg/kg BW. The experiment was ended after a five-days post-treatment period. Milk and blood samples were collected daily during the entire of experiment. Daily milk yield and body weight changes were determined. Milk samples were analyzed for fat, protein, lactose solid not fat and total solid content of the milk. Blood plasma samples were analyzed for GH, T_3 and T_4. Blood plasma GH, T_3 and T_4 concentrations increased significantly ($P\leq0.05$) with increasing the level of injected serotonin. No significant difference were observed between treatments for fat, protein, lactose solid not fat and

total solid content of the milk samples, although daily milk yield and yield of fat and protein increased significantly ($P \leq 0.05$) with increasing the level of injected serotonin agonist. The results of this study indicate that serotonin agonist injection can increase secretion of GH, T_3 and T_4 from hypophysis and consequently improve milk yield in dairy cows.

Key Words: Serotonin, Milk Yield, Dairy Cows

Ruminant Nutrition and Forages

271 Ruminal ammonia load does not impact histidine utilization by growing steers. K. C. Candler*, E. C. Titgemeyer, M. S. Awawdeh, and D. P. Gnad, *Kansas State University*.

Six ruminally cannulated Holstein steers (144 kg) housed in metabolism crates were used in a 6 x 6 Latin square to determine effects of rumen ammonia load on utilization of histidine (His). The basal diet (83% soybean hulls, 8% wheat straw, 0.4% urea, DM basis) was fed twice daily to provide 2.5 kg DM/d. Experimental periods were 6 d, with 2 d for adaptation to treatment and 4 d for total fecal and urinary collection for N balance. Basal abomasal infusions contained: 250 g/d amino acids, which supplied adequate amounts of all essential amino acids except His; 10 mg/d vitamin B-6, 10 mg/d folic acid, and 0.1 mg/d vitamin B-12; and 300 g/d glucose. Basal ruminal infusions contained 180 g/d acetate, 180 g/d propionate, and 45 g/d butyrate to supply energy without increasing microbial protein supply. Treatments were continuously infused, arranged as a 3 x 2 factorial, and included: 0, 1.5, or 3 g/d L-His infused abomasally; and 0 or 80 g/d urea infused ruminally to supply a metabolic ammonia load. Total N intake increased from 89.5 g/d for steers receiving no urea to 126.6 g/d for steers receiving 80 g/d urea. Urea infusions increased ($P < 0.01$) rumen ammonia concentration from 8.6 to 19.7 mM and plasma urea from 2.7 to 5.1 mM. No change in N retention occurred in response to urea (35.1 and 37.1 g/d for 0 and 80 g/d urea, respectively, $P = 0.15$). There also was no His x urea interaction for N retention ($P = 0.64$). Retained N increased linearly ($P < 0.01$) with His (31.5, 37.8, and 39.0 g/d for 0, 1.5, and 3 g/d L-His, respectively). Fecal N was similar among all treatments, so change in N retention resulted from relative changes in N intake and urinary N excretion. Efficiency of deposition of supplemental His between 0 and 1.5 g/d was 50% when steers received no urea and 81% for steers receiving 80 g/d urea. In our model with growing steers, increases in the ammonia load did not demonstrate a metabolic cost in terms of whole body protein deposition, regardless of whether His was limiting.

Key Words: Histidine, Ammonia, Growth

272 Effect of urea concentration in steam-flaked corn diets on nutrient digestion and ruminal kinetics. S.S. Swanek*[1], C.R. Krehbiel[1], and D.R. Gill[1], [1]*Oklahoma State University*.

Increasing urea concentration in isonitrogenous steam-flaked corn diets was investigated. Five ruminally and duodenally cannulated steers (initial BW 37534 kg; 1.160.13 kg ADG) were used in a 5 x 5 Latin square design experiment to determine the effects of urea concentration on intake, nutrient digestion, and ruminal kinetics. Isocaloric ($NE_m = 2.08$ Mcal/kg; $NE_g = 1.31$ Mcal/kg) and isonitrogenous (2.24% N) steam-flaked corn diets with urea concentrations of 0, 0.8, 1.2, 1.6, or 2.0% (DM basis) were offered ad libitum to steers. Following nine days of diet adaptation total urine and feces were collected for four days. On d 14, ruminal fluid was collected at 0, 3, 6, 9, 12, 15, 18, 21, and 24 h after pulse dosing with Co-EDTA. Dietary urea concentration did not affect ($P>0.10$) DM intake. Steers consuming diets containing 1.6% urea had the lowest ($P<0.05$) ADF intake, while steers consuming 0.8 and 2.0% urea diets had the greatest ($P<0.05$) ADF intake. Steers consuming diets containing 0% urea had lower ($P<0.05$) starch intake than steers consuming 2.0% urea diets, and tended ($P=0.06$) to have lower starch consumptions than steers containing 0.8% urea diets. Urea concentration had no effect ($P>0.10$) on fecal output of DM, OM, and starch, or DM, OM, N, and starch digestibility. Steers consuming diets containing 1.6% urea had lower ($P<0.05$) ADF digestibility than steers consuming 0 or 0.8% urea diets. Urea concentration did not influence fecal N output, total N balance, or N balance as a percent of N intake. Similarly, liquid dilution rate and pH were not affected ($P>0.05$) by urea concentration. Our data suggests that high urea concentrations can be utilized in steam-flaked corn finishing diets without altering intake, nutrient digestion, or ruminal kinetics.

Key Words: Ruminal Metabolism, Urea, Degradable Intake Protein

273 Effect of compensatory growth on net metabolite and hormone flux across splanchnic tissues during adaptation to a high-grain diet in beef steers. M. J. Hersom*[1], C. R. Krehbiel[1], G. W. Horn[1], J. G. Kirkpatrick[1], R. P. Wettemann[1], and D. H. Keisler[2], [1]*Oklahoma State University,* [2]*University of Missouri*.

Ten multicatherized steers were used in a completely random design to determine the effect of previous rate of gain on metabolite and hormone flux across total splanchnic tissues (TST) of beef steers fed a high-grain diet. Treatments were high (HG; 1.25 ± 0.14 kg/d; BW = 341 ± 27 kg) or low (LG; 0.73 ± 0.13 kg/d; BW = 265 ± 11 kg) daily gain while grazing winter wheat pasture. After steers were grazed for 69 d, chronic indwelling catheters were surgically placed in the portal vein, a hepatic vein, and a mesenteric artery and vein. Blood flow (BF) and oxygen consumption by portal-drained viscera (PDV) and liver were measured on d 0, 14, 28, 42, 64, and 92 of a high-grain feeding period following priming (20 mL) and continuous infusion of p-aminohippuric acid. Compensatory growth was evident in LG steers (30% compensation by d 28); ADG (2.13 vs 1.31 kg/d; P=0.01) and ADG:DMI (0.221 vs 0.103; P=0.005) were greater from d 0 through 28. Across the 92-d experiment, mean OM digestibility was greater (P=0.01) in HG than LG steers, but N digestibility did not differ (P=0.20). Portal BF increased ($P<0.001$) with days on feed (DOF), but did not differ (P=0.51; 664 L/h) among treatments. Hepatic BF in LG was greater (P=0.05) than HG steers (756>603 ± 40 L/h) and increased ($P<0.001$) with increasing DOF. Ammonia, urea-N, and α-amino N flux across TST did not differ ($P>0.30$) among treatments. Release of glucose from TST did not differ (P=0.47) among treatments, but increased with increasing DOF ($P<0.001$). Insulin PDV release increased ($P<0.001$) and hepatic removal of insulin decreased (P=0.08) in both HG and LG with DOF. Net insulin release from TST increased (P=0.06) with DOF in both HG and LG steers. Leptin ($P>0.39$) and IGF-I ($P>0.29$) TST flux did not differ among treatments. Steers that had lower BW gains (0.73 kg/d) prior to high-grain feeding had increased finishing performance early in the finishing period compared with HG steers. However, performance was not related to nutrient and hormone flux across TST during compensatory growth early in the feeding period.

Key Words: Cattle, Compensatory Growth, Nutrient Flux

274 Effects of roughage level and calcium magnesium carbonate buffer on ruminal metabolism and site and extent of digestion in beef steers fed a high-grain diet. C. D. Keeler*[1], C. R. Krehbiel[1], and J. J. Wagner[2], [1]*Oklahoma State University Stillwater, OK,* [2]*ContiBeef, LLC Lamar, CO*.

Five crossbred steers (initial BW= 263 ± 9 kg) fitted with ruminal and duodenal cannulas were used in a 5 x 5 Latin square design to evaluate the effects of roughage level and calcium magnesium carbonate buffer on ruminal metabolism and site and extent of digestion in beef steers. Steers were allowed ad libitum access to a 90% concentrate feedlot diet consisting of steam-flaked corn and corn silage. Steers were randomly allotted to one of five treatments: 1) 3.8% roughage and 0% buffer; 2) 7.5% roughage and 0% buffer; 3) 11.3% roughage and 0% buffer; 4) 3.8% roughage and 1.5% buffer; and 5) 7.5% roughage and 1.5% buffer. Each period included 16 d for adaptation and 5 d for sampling. Water intake was lower ($P < 0.05$) when 7.5% roughage and 1.5% buffer were fed compared with the other treatments. Dry matter intake did not differ ($P = 0.21$) among treatments, although DMI numerically increased as roughage level increased (6.2, 6.9, and 7.5 0.6 kg/d for 3.8, 7.5, and 11.3% roughage, respectively). Duodenal flow of OM followed a similar trend as intake, and was greater ($P < 0.05$) when 11.3% roughage

was fed compared with 3.8 or 7.5% roughage. Neutral detergent fiber (P = 0.09), ADF (P = 0.01) and N (P = 0.06) intake increased as dietary roughage increased, although ruminal and total tract digestibility of these response variables did not differ (P > 0.10) among treatments. Ruminal fluid volume and turnover time was not influenced (P > 0.10) by roughage level or buffer. Feeding buffer decreased (P= 0.07) fluid flow rate out of the rumen. Ruminal fluid pH was not (P > 0.10) affected by roughage level or buffer. In our experiment, feeding calcium magnesium carbonate buffer did not appear to influence site and extent of digestion.

Key Words: Roughage Level, Buffers, Digestion

275 Relationship between feeding behavior and performance of feedlot cattle. D. D. Hickman*[1], T. A. McAllister[2], K. S. Schwartzkopf-Genswei[3], D. H. Crews, Jr.[2], and C. R. Krehbiel[1], [1]*Oklahoma State University, Stillwater, Oklahoma,* [2]*Agriculture and Agrifood Canada, Lethbridge, Alberta Canada,* [3]*Alberta Agriculture Food and Rural Developement, Lethbridge, Alberta, Canada.*

The relationship between eating patterns and performance of feedlot steers was evaluated using 74 Charolais sired steers (initial BW = 277 ± 111 kg) blocked by BW and assigned to two feedlot pens equipped with a radio frequency identification system (GrowSafe Systems). Each pen featured five feeding stalls that allowed single animal access to a feed tub suspended on load cells. The system recorded animal ID, time, duration and amount of feed consumed during each bunk visit. Barley silage/barley grain backgrounding diets were delivered over an 87-d backgrounding phase and barley grain/barley silage finishing diets were delivered 2 to 3X/d to meet ad libitum intake over the experiment. Steers were weighed every 14 d. To relate feeding behavior to performance, steers were grouped by their DMI, daily intake variation (DV), number of visits to the bunk, duration of visits, ADG, and DMI:ADG and categorized (mean ± SD) as average, high or low. The system allowed for calculation of DV and eating rate (ER). Overall, high ADG steers (1.79 ± 0.11 kg) had the greatest (P<0.001) daily DMI (8.69 > 8.04 > 7.66 ± 0.21kg/d), the greatest (P<0.001) DV (3.08 > 2.94 > 2.72 ± 0.13 kg/d) and spent the least (P<0.001) amount of time at the bunk (99.99 ± 1.21 min/d) compared with average or low steers, respectively. Similarily, when classifying steers according to DMI:ADG, the most efficient steers (5.35 ± 1.18 kg/kg) had the greatest (P<0.001) DV (3.28 ± 0.12 kg/d), the greatest ADG (1.73 ± 0.81 kg) and spent the least (P<0.001) amount of time at the bunk (91.59 ± 2.23 min/d). Steers classified as high ER had the greatest (P<0.001) overall DMI (8,562 ± 269 kg), least (P<0.001) bunk visits (5.56 ± 0.33), spent the least amount of time at the bunk (75.21 ± 2.79 min/d), were the most efficient (6.65 ± 0.16 kg/kg) and had the greatest (P<0.001) ADG (1.40 ± 0.03 kg/d) compared with average or low ER steers. When classifying steers, response variables seemed to follow a similiar trend in each category. Steers with the greatest performance had the most variable eating patterns. The eating pattern portrayed by the high - performing steers included short visits to the bunk, and the greatest DMI with the greatest variation in day to day intake.

Key Words: Feedlot, Behavior, Performance

276 Tympanic temperature and behavior associated with moving feedlot cattle. T. L. Mader*[1], M. S. Davis[2], and W. M. Kreikemeier[1], [1]*University of Nebraska,* [2]*Koers-Turgeon Consulting Service, Inc.*.

The effect of activity on body temperature is particularly important when body temperature is used as an indicator of health status or when environmental conditions exist which could contribute to heat stress. In two winter and two summer studies, tympanic temperature (TT), an indicator of body temperature, was obtained in unrestrained yearling, feedlot cattle. The objectives of these studies were to evaluate effects of cattle movement in the feedyard and quantify TT of animals moved various distances and at different times during the year. Groups of cattle (four to six head) were moved through working facilities a total distance of 150m (January), 300m (February), 150 or 600m (August), and 1,000, 2,000 or 3,000m (June). Baseline TT was determined on non-moved days. During the winter and summer studies, TT were recorded every 15 minutes and 2 minutes, respectively. Moving cattle elevated mean TT between 0.3 and 0.8°C (P< 0.05), with individual animals displaying TT increases of over 1.5°C. Season effects were not apparent. During these studies, climatic conditions were near normal in the summer, while ambient temperatures were slightly above normal in the winter. Peak TT usually occurred between 15 and 30 minutes after initiation of cattle movement; an additional 1 to 4 hours were required for TT to return to normal levels. Only in August was a change in TT closely related to total distance moved (.3 and .7°C for 150 and 600m move, respectively; P < 0.05). In the June study, moving cattle resulted in fewer (P < 0.1) cattle at the bunk, in the morning, and more (P < 0.05) cattle standing in both morning and afternoon. Effects of cattle movement and handling on body temperature need to be taken into account when evaluating animal health studies. Furthermore, minimal handling of cattle during hot days is recommended for promoting and maintaining animal comfort.

Key Words: Beef Cattle, Tympanic Temperature, Processing

277 Vaccination and feeding a competitive exclusion product as intervention strategies to reduce the prevalence of *Escherichia coli* O157:H7 in feedlot cattle. J.D. Folmer*[1], C.N. Macken[1], G.E. Erickson[1], T.J. Klopfenstein[1], M.L. Khaitsa[1], S. Hinkley[1], R.A. Moxley[1], D.R. Smith[1], A.A. Potter[2], and B. Finlay[3], [1]*University of Nebraska,* [2]*University of Saskatchewan,* [3]*University of British Columbia.*

A clinical trial was conducted to test the effect of vaccination (**V**) and feeding a competitive exclusion (**CE**) product on the proportion of feedlot steers shedding *Escherichia coli* O157:H7 (**O157**) in feces. Three hundred eighty-four steers were blocked by weight, stratified by weight within block and assigned randomly to 48 pens. The finishing diet of 55% high moisture corn, 35% wet corn gluten feed, 5% corn silage, 2% alfalfa hay, 2% supplement, and 1% water was identical for all treatments and contained a minimum of 12.5% CP, 0.7% Ca, 0.65% K, and 0.3% P. CE and V treatments were allocated to pens in a 2 x 2 factorial design with three weight blocks and twelve repetitions per treatment. The V, designed to immunize against secreted proteins of O157, was administered 3 times at 3-week intervals to cattle within assigned pens beginning d-0 of each block. A *Lactobacillus acidophilus* CE product was fed with the ration continuously from d-24 of the trial. Samples of rectal feces were collected for bacterial culture. Each block was sampled every three weeks for the entire 121d (May-September) feeding period resulting in 1 pre-treatment and 5 test-period samplings. Outcome measures were pen-level performance and the proportion of animals per pen culture-positive for O157. Feedlot performance and O157 outcomes were analyzed using MIXED procedures of SAS accounting for repeated sampling for O157. Treatment groups did not differ in performance (ADG, DMI, gain to feed, marbling score, fat thickness, or yield grade). The pre-treatment prevalence of O157 averaged 31%, and did not differ significantly between treatments (P=0.19). The average proportion of cattle shedding O157 differed (P=0.01) over the 5 test-periods (18.5%, 10.2%, 11.7%, 4.4%, and 18.8%, respectively); however, no interaction was observed between treatments or between treatment and time. The average proportion of cattle shedding O157 for treatments of control, CE alone, V alone, and CE with V were 21.3%, 13.3%, 8.8%, and 7.7%, respectively. Adjusting for the effect of CE and block, the proportion of cattle shedding O157 in V treated pens was significantly less than non-V pens (P=0.03). V alone, or possibly in combination with CE feeding, may be useful to reduce prevalence of O157 in feedlot cattle.

Key Words: Feedlot Cattle, Intervention, *E. coli* O157:H7

278 Performance of dairy heifers fed high forage diets supplemented with bambermycins, lasalocid, or monensin. A. K. Hammond*, J. E. Shirley, M. V. Scheffel, E. C. Titgemeyer, and J. S. Stevenson, *Kansas State University.*

One hundred twenty Holstein heifers initially weighing 205 kg were used to evaluate the impact of bambermycins, lasalocid, and monensin on performance when included in high forage diets fed ad libitum. Bambermycins, lasalocid, and monensin were mixed with finely ground corn and fed as topdressing to deliver 20.25, 150, and 150 mg/heifer daily, respectively. Diets were formulated (NRC, 2001) to support body weight gains of less than 0.91 kg/d using a mix of chopped alfalfa hay and corn silage (lighter weight heifers) or chopped alfalfa hay, chopped prairie hay, and corn silage (heavier weight heifers) supplemented with a mineral/vitamin premix. All heifers were fed a common total mixed ration, differing only in topdressing. Diets were fed once daily for ad libitum intake. The study continued until the average body weight exceeded 364 kg (140 d) at which time they were inseminated and first service

conception rate determined. Heifers fed monensin consumed less dry matter (P < 0.05) than those fed bambermycins and lasalocid during the periods d 29 to 56, 57 to 84, and 113 to 140. Dry matter intake was similar across treatments during the 140-d study. No differences were observed for average daily gain, but heifers fed bambermycins and monensin tended (P = 0.06) to gain faster during d 85 to 112 than heifers fed lasalocid. Heifers consuming diets containing bambermycins and monensin were more efficient (P < 0.05) during d 85 to 112 and tended to be more efficient (P = 0.051) during the 140-d study than heifers consuming lasalocid. Body weight, condition score, and hip height were not affected by dietary treatments. First service conception rates were 60, 47, and 55% for heifers fed bambermycins, lasalocid, and monensin, respectively.

Key Words: Ionophores, Growth, Heifers

279 A flow cytometric method for intracellular analysis of glutathione concentration in bovine natural killer cells. L. A. Matulka*[1], L. Wilkie[2], C. Kusznyski[2], D. R. Brink[1], and C. L. Kelling[1], [1]*University of Nebraska, Lincoln, NE,* [2]*University of Nebraska Medical Center, Omaha, NE.*

Glutathione (GSH), a tripeptide composed of glutamic acid, cysteine, and glycine, is an anti-oxidant and an important regulator of cell function. The immune system works best if the lymphocytes have a balanced level of GSH. Cellular GSH concentration may be amenable to nutrition because cysteine availability is markedly influenced by diet. Diseases that are associated with a glutathione deficiency result in impaired immunological function. Measurement of intracellular GSH concentration in bovine natural killer (NK) cells will play an important role in determining the basis for altered NK cell function during infection. The traditional method for GSH measurement is high performance liquid chromatography. In the present study intracellular GSH concentrations in bovine NK cells were determined using flow cytometric analysis. Peripheral blood mononuclear cells were prepared by Ficoll-Paque density centrifugation and enriched for NK cells (1000U/ml of interleukin-2 for 72 h at 37 °C and 5% CO_2). After incubation mononuclear cells were stained with antibodies recognizing CD2 and CD3 to identify NK cells (CD2+, CD3-). Cells were sorted using a Becton Dickinson FACSVantage SE (92% NK cells). NK cells were further stained with monochlorobimane and intracellular GSH levels were determined as the fluorescence produced from the GSH-s-transferase conjugation of monochlorobimane with GSH. This method of fluorescence activated cell sorting (FACS) coupled with multiparameter immunofluorescence sub setting allowed for GSH levels of a particular cell type (NK cells) to be determined. This method allows for a rapid means to sort viable cells by their GSH levels then assay functionality of the cell.

Key Words: Glutathione, Flow Cytometry, NK Cells

280 Effects of high selenium wheat on carcass weight, visceral organ mass and intestinal growth in finishing beef steers. S. A. Soto-Navarro*[1], T. L. Lawler[2], J. B. Taylor[2], L. P Reynolds[1], J. J. Reed[1], and J. S. Caton[1], [1]*North Dakota State University, Fargo,* [2]*USDA, ARS, U.S. Sheep Experiment Station.*

Twelve crossbred steers (351.1 24.1 kg initial BW) were used to determine effects of high selenium (Se) wheat on visceral tissue mass and intestinal cell growth. Steers were allotted randomly by weight to one of two treatments consisting of 75% concentrate diets that supplied: 1) adequate Se level (7 to 12 g kg BW^{-1} d^{-1}), or 2) high Se level (60 to 70 g kg BW^{-1} d^{-1}). Diets were similar in feedstuff composition (25% grass hay, 25% wheat, 39% corn, 6% desugared molasses, and 5% wheat middlings supplement, DM basis). In the Se treatment, high Se wheat (10 ppm) was exchanged for commodity wheat (0.35 ppm). Diets were formulated to be similar in nitrogen and energy (14.0% CP, 2.12 Mcal NEm/kg, and 1.26 Mcal NEg/kg DM) and were offered once daily (1500) individually to steers in a Calan Gate System. After 126 d, steers were slaughtered and individual visceral tissue weights determined. In addition, intestinal tissue protein, DNA, and RNA concentrations, and cell proliferation were determined. No effects were observed ($P > 0.05$) for mass of empty body, hot carcass, digesta, liver, spleen, kidney, duodenum, ileum, or small intestine. Concentrations of DNA, RNA, and protein of duodenum, ileum, and total small intestine were also unaffected by treatment. Ratios of RNA:DNA and Protein:DNA in duodenum, jejunum, ileum, and whole small intestine were not ($P > 0.10$) affected by high Se wheat. Conversely, jejunal weight was greater ($P < 0.002$) in steers fed high Se wheat compered with controls (916 vs 1427 84 g). Jejunal DNA was increased ($P < 0.04$) in high Se steers (2.95 vs 3.56 0.19 mg/g) suggesting increased cell number. Concentrations of jejunal RNA and protein were not altered ($P > 0.59$) by treatment; however, since the jejunal weight increased in high Se steers, DNA, RNA, and protein contents (g) were greater ($P < 0.05$). Jejunal crypt cell proliferation was unaffected ($P > 0.1$) by treatment. These data indicate that diets high in Se (provided from wheat) result in increased jejunal mass and DNA which is not explained by changes in crypt cell proliferation.

Key Words: Selenium, Intestinal Mass, Cellular Proliferation

281 Influence of dietary encapsulated ascorbate and α-tocopherol on performance, serum antioxidant concentrations and white blood cell changes of transit stressed wether lambs. N. K. Chirase*[1,2], L. W. Greene[1,2], N. A. Cole[3], and D. Putnam[4], [1]*Texas Agric. Exp. Sta., Amarillo,* [2]*West Texas A&M Univ., Canyon,* [3]*USDA/ARS, Bushland,* [4]*Balchem Encapsulates, Middletown, NJ.*

Animals often encounter many environmental stressors and pathogens associated with modern animal production which could compromise the antioxidant and immune defense systems. An experiment was conducted to determine the effects of dietary encapsulated ascorbate (VitC), α-tocopherol (VitE), and a combined encapsulated VitC and VitE (VitCE) on performance, serum antioxidants concentrations and white blood cell (WBC) changes of transit stressed wether lambs. Twenty four lambs (average BW 36 kg) were allotted randomly into 4 groups, and individually fed (ad libitum) a basal diet with a ground corn premix (100 g/d) containing the following antioxidant supplements: 1) Control (ground corn), 2) VitC (2 g/d), 3) VitE (490 IU/kg DM), and 4) VitCE (VitC 2 g/d and VitE 490 IU/kg DM). The basal diet contained 75% concentrate, 25% roughage, 15.6% CP, 54 IU of α-tocopherol/kg and unknown ascorbate content. Lambs were adapted to their diets and pens for 28 d pretransit. Daily feed intake (d 0 to 28) and BW were measured and blood samples taken every 7 d. Harvested serum or plasma was used for retinol (VitA), α- and γ-tocopherol and ascorbate assays. On d 29, lambs were transported (1158 km) by truck and a trailer for 12 h after 24 h of fasting. Sampling and analysis procedures were repeated every 7 d for 28 d, and WBC counts performed. The data were analyzed using Mixed Models procedures of SAS. Lambs fed VitC or VitE had lower (P < 0.05) pretransit feed intake, ADG, and gain to feed ratio than those fed VitCE. Serum α-tocopherol concentration (ug/ml) was greater (P < 0.05) in lambs fed VitE or VitCE than lambs fed control or VitC. Lambs fed VitC or VitCE had lower monocytes and higher (P < 0.05) hemoglobin concentrations than controls. Encapsulated antioxidants increased serum antioxidants and hemoglobin concentrations of transit stressed lambs.

Key Words: Lambs, Encapsulated Antioxidants, Transit Stress

282 Effect of energy level and a fibrolytic enzyme on performance and health of newly received shipping stressed calves. R.E. Peterson*[1], C.R. Krehbiel[1], D.R. Gill[1], and C.E. Markham[1], [1]*Oklahoma State University, Stillwater, OK/USA.*

Maintaining health of newly received shipping stressed calves in the feedlot continues to be problematic for feedlot managers. Diets and (or) feed additives that can improve digestibility and (or) boost the immune system might be important for the overall health and performance of newly received shipping stressed calves. The objective of this experiment was to determine the effect of increasing dietary energy with or without a fibrolytic enzyme on health and performance of sale-barn origin calves during a 56-d receiving study. Four truckloads (approximately 100 calves/load) of calves (avg initial BW = 213 16 kg) were received at the Willard Sparks Beef Research Center during the months of January, February, and March 2002. Calves were blocked by weight and randomly assigned to pens with each pen having a randomly assigned dietary treatment. Dietary treatments were arranged in a 2 x 2 factorial: 1) low energy; 2) low energy + enzyme (215 mg/kg of DM); 3) high energy; and 4) high energy + enzyme (215 mg/kg of DM). The low-energy diet consisted of 60% alfalfa hay, 10% cottonseed hulls (CSH), 24% dry rolled corn (DRC), 5% molasses and 1% supplement (NEm = 1.49 Mcal/kg; NEg = 0.85 Mcal/kg). The high-energy diet consisted of 25% alfalfa hay, 10% CSH, 50% DRC, 5% molasses and 10% supplement (NEm = 1.81 Mcal/kg; NEg = 1.10 Mcal/kg). Low and high-energy diets were formulated for 180 kg medium-framed calves to gain 0.82 and

1.27 kg/d, respectively. Data were analyzed using the MIXED procedure of SAS. Feeding enzyme did not affect (P > 0.20) overall ADG, DMI or ADG:DMI; however ADG tended (P = 0.06) to be greater from d 15 through 28 for calves consuming the high-energy diets. In addition, ADG:DMI tended (P = 0.06) to be greater from d 15 through 28 and d 0 through 56 for calves consuming the high-energy diets. Morbidity was not influenced (P > 0.10) by energy level or by the addition of a fibrolytic enzyme. In our experiment, health and performance of newly recieved shipping stressed calves was not affected by the addition of a fibrolytic enzyme. However, increasing dietary energy improved feed effeciency by 14.6%. Because increasing energy did not negatively affect the health of calves in this experiment, we conclude that economics should dictate the recieving strategy.

Key Words: Stressed Calves, Energy, Fibrolytic Enzyme

283 Nutrient sources for dehydrated neonatal calves. T. M. Hill*, J. M. Aldrich, and R. L. Schlotterbeck, *Akey, Lewisburg, OH.*

Various nutrients from electrolytes, milk replacer (MR), immunoglobulin products from plasma and serum, and milk protein without fat or lactose were fed to transported calves to determine their effect on gain and health in three different trials using 300 Holstein bull calves. In all trials, calves less than a week old were shipped 10 h and randomly assigned to a one-dose treatment administered on arrival. After day one, calves were fed 454 g daily of a 20% protein, 20% fat MR for 6 weeks. An 18% crude protein starter and fresh water was offered at all times for 8 weeks. Calves were weighed initially (averaged 41 kg) and weekly. Starter intake, fecal scores, and medical treatments were recorded daily. Data were analyzed as a completely randomized block design with means separated using Student Newman Keuls test. In trial 1 (102 calves), the treatments were: 113 g electrolytes (E1), 227 g high plasma protein MR plus electrolytes (MRE1), and 227 g commercial serum product (S). Daily gains were greater (P < .1) and medical treatments were lower (P < .1) for all cumulative weeks for calves fed E1. Treatment MRE1 contained lactose and fat and S contained lactose; thus a lactose- and fat-free treatment (CC) was applied in Trials 2 and 3. In trial 2 (48 calves), the treatments were feeding 113 g of one of two electrolytes (E1, E2) and 227 g milk protein plus electrolytes source (Critical Care; CC). Daily gains were greater (P < .1) for all cumulative weeks and medical treatments were lower (P < .1) or tended to be lower for all cumulative weeks for calves fed CC. In trial 3 (150 calves), the treatments were feeding 113 g electrolytes (E2) and 227 g of a milk protein plus electrolyte source (CC). Daily gains were greater (P < .1) for weeks 0-1 and tended to be greater for all cumulative weeks for calves fed CC. These data indicate that electrolytes and milk protein are suitable nutrient sources to promote gain and reduce health problems in transported calves.

Key Words: Calves, Dehydration, Nutrients

284 Evaluation of a plant extract, Apex, included in calf milk replacers. T. M. Hill*, J. M. Aldrich, and R. L. Schlotterbeck, *Akey, Lewisburg, OH.*

Non-antibiotic products that have anti-microbial and antioxidant properties are appealing in the calf feed marketplace in the US and abroad. Apex CMR 3035, a commercial plant extract combination product from Braes Feed Ingredients was evaluated in each of two milk replacers (MR; 20% protein, 20% fat, and .05% decoquinate) with different protein sources. The treatments were: A) all milk protein with .05% Apex, B) all milk protein without Apex, C) 55% milk protein plus 45% soy protein concentrate protein with .05% Apex, and D) 55% milk protein plus 45% soy protein concentrate protein without Apex. Calves were fed 454 g daily of MR for 6 weeks. An 18% crude protein starter (.0025% decoquinate) and fresh water was offered at all times for 8 weeks. Calves were weighed initially (averaged 40 kg) and weekly. Starter intake, fecal scores, and medical treatments were recorded daily. Hip widths and body condition was measured initially and every 2 weeks. Data were analyzed as a completely randomized block design with factors in the model of block (row in barn), MR (all milk or milk plus soy protein), Additive (Apex or no Apex), and MR X Additive. There were no significant (P > .1) interactions of MR X Additive. Both MR and Additive were significant (P < .1) for gain. Calves fed Apex gained faster (P < .1) during the first week and cumulative weeks of 2, 3, 4, 5, and 6 than calves not fed Apex. Cumulative feed efficiency was better (P < .1) for calves fed Apex vs. calves not fed Apex for cumulative weeks through week 4, 5, 6, 7, and 8. Calves fed Apex had greater (P < .1) hip width changes during weeks 0-4, 0-6, and 0-8 than calves not fed Apex. The all milk protein MR supported 25% faster gains than the milk plus soy MR over the 6-week milk-fed period. Feeding Apex increased calf gains by 8% (496 vs. 457 g daily) with the all milk protein MR, 17% with the milk plus soy MR (412 vs. 350 g daily), and 12% across both MR types over the 6-week milk-fed period.

Key Words: Calves, Milk Replacer, Plant Extract

285 Improvement of the growth and performance of Holstein neonatal calves receiving the microbial additive *Saccharomyces cerevisiae* (Iran Molasses Co., 2002). B. Saremi* and A. Naserian, *Ferdowsi University Of Mashhad, IRAN.*

Yeasts such as strains of *Saccharomyces cerevisiae* (SC) are now widely used as additives in ruminant nutrition to improve animal performance, health and utilization of nutritional components of their diet while at the same time avoiding nutritional disorders. So the objective of this study was to determine if this Bakery's yeast product could positively affect calves growth and performance. Eighteen female Holstein neonatal calves were used in this study and randomly placed on treatments in a completely randomized design and fed colostrum at 10% of birth weight and milked until 45 d old. All calves were fed calf starter (NRC 2001) containing high quality alfalfa (15%) from 7 d of age and weaned at 45 d. Calf starter was offered until 90 d old, and the yeast was added daily at 0, 0.5 and 1% to the calf starter. The weight, frame measures and rectal temperature were taken from 0 to 90 d in regular periods. Feed intake was measured daily. There was a difference between daily DMI of calves and rectal temperature in treatments but no difference in ADG, calves weight in periods, metabolic weight, feed efficiency or rumen pH. Addition of SC to the calf starter had no effect on body length, pin width, hip width, pin to hook length, metacarpus and metatarsus size but had a considerable effect on wither height, hip height, stomach size and hearth girth in treatments. The results of this study demonstrate that SC can reduce the DMI without significant effect on the ADG, feed efficiency of calves and rumen pH.

Item	0% yeast (T1)	0.5% yeast (T2)	1% yeast (T3)	SEM	P Values
Daily DMI (kg)	1.05^a	0.93^b	0.93^b	0.37	P≤0.0001
Rectal temperature (°C)	39.4^a	39.2^b	39.4^a	0.43	P≤0.05
ADG (kg)	0.38^a	0.35^a	0.36^a	0.19	P≥0.73
Calves weight (Kg)	58.0^a	56.0^a	56.7^a	7.92	P≥0.43
Metabolic weight (Kg)	20.8^a	20.4^a	20.5^a	2.09	P≥0.51
Feed efficiency	1.01^a	0.98^a	0.95^a	0.29	P≥0.76
Rumen pH	5.79^a	5.78^a	5.94^a	0.46	P≥0.25
Frame measurements					
Wither height (cm)	84.1^a	82.7^{ab}	81.7^b	3.22	P≤0.01
Hip height (cm)	89.0^a	88.2^{ab}	86.9^b	3.34	P≤0.03
Stomach size (cm)	107^a	103^b	105^a	4.77	P≤0.01
Hearth girth (cm)	92.9^a	91.0^b	91.7^{ab}	2.76	P≤0.02

Key Words: Saccharomyces Cerevisiae, Growth and Performance, Neonatal Calves

286 Rumen, plasma, and milk conjugated linoleic acid and transvaccenic acid response to fish oil supplementation of diets differing in fatty acid profiles. A. AbuGhazaleh[2], D. Schingoethe*[1], A. Hippen[1], and K. Kalscheur[1], [1]*South Dakota State University,* [2]*Clemson University.*

The objective of this study was to examine the effect of feeding fish oil (FO) along with fat sources that varied in their fatty acid compositions (high stearic, high oleic, high linoleic, or high linolenic acids) on rumen, plasma, and milk fatty acid profiles. Four primiparous Holstein cows at 85 DIM (± 40) were used in a 4 × 4 Latin square with 4-wk

periods. Treatment diets were 1) 1% FO plus 2% fat source high in stearic acid (HS); 2) 1% FO plus 2% fat from high oleic acid sunflower seeds (HO); 3) 1% FO plus 2% fat from high linoleic acid sunflower seeds (HLO); and 4) 1% FO plus 2% fat from flax seeds (high linolenic; HLN). Diets formulated to contain 18% crude protein were composed of 50% (dry basis) concentrate mix, 25% corn silage, 12.5% alfalfa haylage, and 12.5% alfalfa hay. Milk production (31.7, 31.5, 28.9, and 29.6 kg/d), DMI (22.3. 21.8, 22.3, and 22.0 kg/d), and milk protein percentages and yields were similar across diets. Milk fat percentages (3.10, 2.74, 2.64, and 3.09) and yields (0.99, 0.86, 0.77, and 0.91 kg/d) for diets 1 to 4 were lowest for HO and HLO diets. The proportions of ruminal cis-9, trans-11CLA (0.09, 0.16, 0.18, and 0.16 g/100g FA) were similar for the HO, HLO, and HLN diets and all were higher ($P < 0.10$) than the HS diet. The proportions of ruminal TVA (2.85, 4.36, 8.69, and 4.64 g/100g FA for diets 1 to 4) increased ($P < 0.10$) with the HO, HLO, and HLN diets compared with the HS diets and the increase was greatest with the HLO diet. The effects of fat supplements on ruminal TVA concentrations were also reflected in plasma triglycerides (2.75, 4.64, 8.77, and 5.42 g/100g FA for diets 1 to 4), however, there were no differences in the proportion of cis-9, trans-11 CLA (0.06, 0.07, 0.06, and 0.07 g/100g FA for diets 1 to 4). The higher TVA to cis-9, trans-11 CLA ratio in the rumen digesta and plasma triglycerides compared with milk indicated that fat supplements increased milk cis-9, trans-11 CLA concentration mainly by increasing ruminal production of TVA, which also implied the significant role that mammary delta-9 desaturase plays in milk CLA production.

Key Words: Fish Oil, Conjugated Linoleic Acid, Rumen

287 Field pea replacement value in calf weaning transition diets.

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In a two year study, 299 beef steer and heifer calves were weaned and moved to the Dickinson Research Extension Center's growing lots to evaluate the effect of a 37d conditioning period in which field peas replaced a portion of commonly used fiber-based ingredients (soyhulls, wheat midds, barley malt sprouts) on postweaning diet composition, subsequent feedlot performance, carcass quality and system economics. Pelleted treatments fed were: 1) SBM/Corn, 2) Pea/Corn, 3) 0% Pea, 4) 10% Pea, 5) 20% Pea and 6) 30% Pea. Test diets replaced approximately 70% of the hay offered. ADG (37d) was greater for calves receiving SBM/Corn, 0,10 and 20% pea replacement diets (P<.0002). Calves receiving a diet with no added pea consumed more feed/d. (P<.0001) than calves offered SBM/corn, 10 and 20% pea test diets. Replacing 30% of fiber-based ingredients with peas depressed gain (P<.0002), feed intake (P<.0001), and numerically increased feed required/pound of gain. Feed efficiencies among the test diets were 7.23, 8.34, 7.34, 7.0, 7.23, 9.1, for treatments 1-6, respectively, but did not differ. Steer calves were fed to final harvest at Decatur Co. Feedyard, Oberlin, KS. Steers that received 0 and 20% pea weaning diets required numerically fewer days on feed. No difference was measured for hot carcass weight(P>.59), REA(P>.53), marbling score(P>.14), yield grade(P>.18), quality grade(P>.13) or percent choice(P>.15). Regarding carcass quality, steers receiving a 20% pea replacement diet graded numerically higher (71.3% Choice), however, heavier final carcass weight and lower weaning feed cost among steers started on the SBM/Corn weaning diet combined to increase net return, despite a lower number of carcasses grading choice (45.1%). Highest enterprise net returns of $179.24, $168.90, and $166.56/Hd were realized for steers receiving SBM/corn, 0 and 20% pea test diets, respectively. Overall, enterprise net return favored selling after a short 37d weaning period (ave =$264.10) vs. retaining ownership (ave=$160.57).

Key Words: Field Peas, Calves, Weaning Diets

288 Effects of ethyl 2-butynoate and 3-butenoic acid on in vitro ruminal fermentation.

E.M. Ungerfeld*, S.R. Rust, and R. Burnett, *Michigan State University, East Lansing, MI.*

The objective of this study was to evaluate the effects of combinations of the methanogenesis inhibitor, ethyl 2-butynoate, and the fermentation promoter, 3-butenoic acid, on batch mixed ruminal cultures. Under a 3 x 2 factorial arrangement, ethyl 2-butynoate at 0, 4, and 8 mM initial concentration was combined with 3-butenoic acid at 0 and 4 mM initial concentration. Ruminal fluid was extracted from two dairy cows fed a roughage diet. Finely ground alfalfa hay was used as a substrate. Four Wheaton bottles were used per combination and incubated in a shaking water bath for 24 h. Ethyl 2-butynoate at 4 and 8 mM decreased ($P < 0.01$) methane production by 49 and 100%, respectively. Both 3-butenoic acid effect and the interaction between both additives were statistically significant ($P < 0.05$), but biologically negligible. Ethyl 2-butynoate at 4 and 8 mM caused an accumulation of dihydrogen ($P < 0.01$; quadratic response), while 3-butenoic acid had no effect. Ethyl 2-butynoate decreased ($P = 0.03$; quadratic response) carbon dioxide production, while 3-butenoic acid increased it ($P = 0.04$). Ethyl 2-butynoate decreased ($P < 0.01$; quadratic response) the acetate to propionate ratio from 3.15 to 2.39, while 3-butenoic acid increased ($P < 0.01$) it from 2.52 to 2.87. Ethyl 2-butynoate caused ($P < 0.01$) an increase in ethanol production. Both additives decreased ($P < 0.01$) the final pH. None of the additives had an effect on ammonia concentration. Ethyl 2-butynoate at 4 and 8 mM decreased ($P = 0.02$; quadratic response) substrate fermentation as estimated by a mass balance (assuming complete disappearance of the additive) by 2.5 and 13 percentage units, respectively. 3-Butenoic acid increased ($P = 0.04$) substrate fermentation by 3.9 percentage units. At 4, but not 8mM ethyl 2-butynoate, 3-butenoic acid could overcome the decrease in fermentation caused by ethyl 2-butynoate.

Key Words: Methane, Rumen, Inhibition

289 Effect of frequency of protein supplementation on intake, nitrogen balance, and VFA proportions in beef steers consuming low-quality, tallgrass-prairie forage.

C. G. Farmer*, R. C. Cochran, E. C. Titgemeyer, and T. A. Wickersham, *Kansas State University, Manhattan.*

The impact of supplementation frequency on forage use, N balance, and ruminal VFA proportions was evaluated. Four ruminally fistulated beef steers (BW=513 kg) were used in a 2 x 2 crossover design with two periods and two supplementation frequency treatments, allowing for 4 replications. Supplementation frequencies were 2 and 7 d/wk. Steers were fed tallgrass-prairie hay (73.1% NDF, 5.3% CP) ad libitum. The supplement (42% CP) was fed at 0.36% BW/head daily to steers supplemented 7 d/wk, whereas steers supplemented 2 d/wk received the same amount of supplement per week but equally split among supplementation days. Steers supplemented 7 d/wk had higher ($P < 0.06$) forage and total digestible OM intake. Forage DM intake of steers supplemented 2 d/wk tended to decrease on their day of supplementation. Steers supplemented 7 d/wk had greater ($P < 0.02$) total N intake, fecal N, and N retention, whereas steers supplemented 2 d/wk had higher ($P < 0.01$) urinary N excretion. But, both treatment groups had positive N balance. Ruminal fluid samples were collected at 0, 2, 4, 6, 12, 24, 48, and 72 h post-supplementation beginning on a day when both groups were supplemented. Total VFA concentration was not different ($P = 0.35$) due to supplementation frequency. Frequency x hour interactions ($P < 0.01$) were observed for all molar proportions of VFA. The molar proportion of acetate and acetate:propionate ratio was lower and the molar proportion of propionate and butyrate were higher for steers supplemented 2 d/wk from 4 h to 24 h post-supplementation. Proportions of branched-chain VFA were lower for steers supplemented 2 d/wk from 0 to 6 h post-supplementation, but by 12 h post-supplementation was higher. In conclusion, forage intake and N balance were improved with increased supplementation frequency, although some desirable shifts in VFA proportions accompanied infrequent delivery of large supplement amounts.

Key Words: Frequency, Supplementation, Nitrogen

290 Effect of frequency of protein supplementation on ruminal nitrogen metabolism in beef steers consuming low-quality, tallgrass-prairie forage.

C. G. Farmer*, R. C. Cochran, T. G. Nagaraja, and T. A. Wickersham, *Kansas State University, Manhattan.*

The impact of supplementation frequency on ruminal nitrogen metabolism over time was evaluated. Four ruminally fistulated beef steers (BW=513 kg) were used in a 2 x 2 crossover design with two periods and two supplementation frequency treatments, allowing for 4 replications. Supplementation frequencies were 2 and 7 d/wk. Steers were fed tallgrass-prairie hay (73.1% NDF, 5.3% CP) ad libitum. The supplement (42% CP) was fed at 0.36% BW/head daily to steers supplemented 7 d/wk, whereas steers supplemented 2 d/wk received the same

amount of supplement per week but equally split among supplementation days. Ruminal fluid samples were collected at 0, 2, 4, 6, 12, 24, 48, and 72 h post-supplementation beginning on a day when both groups were supplemented. Frequency x hour interactions ($P < 0.02$) were observed for all ruminal nitrogen metabolism characteristics. Counts of bacteria that can use short peptides and AA as their sole energy source (ammonia-releasing bacteria) peaked at 2 h and returned to nadir by 12 h for steers supplemented 7 d/wk, whereas steers supplemented 2 d/wk peaked at 6 h with a much greater population and returned to nadir at 72 h. Ruminal ammonia concentrations followed a trend similar to the ammonia-releasing bacteria. Specific activity of ammonia production was lower immediately after supplementation for steers supplemented 2 d/wk, but by 12 h was the same as for 7 d/wk steers. Ruminal peptides and free AA peaked at 2 h for steers supplemented 2 d/wk and were generally higher during the first 6 h compared with steers supplemented 7 d/wk. In conclusion, it appears that observed differences in the ammonia concentration in steers supplemented infrequently may have been due to differences in the population of ammonia-releasing bacteria present following extended supplement withdrawal.

Key Words: Frequency, Supplementation, Ammonia

291 Nitrogen and phosphorus utilization by beef cattle fed three dietary crude protein levels with three levels of supplemental urea.

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Three dietary CP levels (11.5, 13.0, and 14.5% of DM) and three supplemental urea levels (100, 50, and 0% of supplemental CP from urea) were fed to determine performance, serum urea N (SUN), and N and P balance. Crossbred steers (n = 27; average BW = 315 kg) were blocked by weight and individually fed the nine treatments in a completely randomized block design. A steam flaked corn-based diet was fed, with supplemental CP supplied by either all urea, a 50:50 blend of urea and cottonseed meal (CSM), or all CSM. Steers were used in three nutrient balance collection periods (NBCP) at the beginning, middle, and end, of the feeding period. Venous jugular blood was obtained at the start and end of each NBCP. No CP level x CP source interactions ($P < 0.10$) were observed. Steer DMI, ADG, and feed efficiency did not differ ($P < 0.10$) among treatments. For each NBCP, urinary total N, urinary urea N (UUN), and SUN increased linearly ($P < 0.10$) as CP level increased. For NBCP 1 and 3, fecal N output increased linearly ($P < 0.10$) as supplemental CP from urea decreased. For NBCP 2 and 3, UUN decreased linearly ($P < 0.10$) as urea level decreased. For NBCP 1, fecal and urine P excretion increased linearly ($P < 0.10$), and P retained (% of intake) decreased linearly ($P < 0.10$), as CP level increased. Phosphorus intake increased linearly ($P < 0.10$) as urea level decreased for each NBCP. Fecal P output increased linearly ($P < 0.10$) in all NBCP, and urinary P excretion in NBCP 1 and 2 increased linearly ($P < 0.10$) as urea level decreased. Phosphorus retained (% of intake) decreased linearly ($P < 0.10$) as urea level decreased for NBCP 3. Results suggest that as dietary CP level increased, N retention decreased, and as supplemental CP supplied by urea decreased P balance decreased in feedlot steers. As days on feed increased, less N and P were retained, suggesting the potential to decrease N and P excretion by feeding less N and P as the feeding period progresses.

Key Words: Feedlot, Nitrogen, Phosphorus

292 Nitrogen retention and apparent digestibility of diets differing in concentration of soybean hulls fed to growing lambs.

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The objective of this study was to determine digestibility, nitrogen retention, and efficiency of nutrient utilization of diets containing increasing levels of soy hulls fed growing lambs. Basil diet contained ground corn, soybean hulls, and hay crop silage. Soy hulls replaced corn at 25%, 50%, 75% or 100%. All lambs were fed ad libitum concentrate (1450 - 1800 g DM /day) and hay crop silage at 10% diet DM. Diet D, with 25% soy hulls, is the basil diet. Twelve whether lambs (27-34 kg BW) were assigned in a 3 period switch-back. Period contained 21d, 14 d adaptation, and 7d total collection of urine and feces. Efficiency and utilization of DM, OM, N, and ADF were measured as soybean hulls replaced corn. Composition of diets A, B, C, D and soy hulls were respectively, DM %, 84.1, 83.8, 84.9, 82.7, and 90.5; N %, 3.10, 1.97, 2.50, 2.39, and 2.78; ADF %, 39.9, 36.5, 27.6, 17.1 and 44.1. Intake and apparent digestibility of DM, and OM were not different between treatments. Nitrogen intake, digestibility, and retention were significantly different ($P<.01$). Intake of ADF, g/d was significantly increased as soy hulls replaced corn ($P<.01$). However, diet ADF digestibility was not significantly different ($P>.20$). Nitrogen retention, and apparent digestibility of N, DM, and ADF were not compromised by replacement of corn with soy hulls in diets fed growing lambs.

Diet	A	B	C	D	SE
DM-intake, g/d	1483.9	1520.6	1372.0	1431.5	64.2
N-intake, g/d	46.1	30.2	34.7	34.8	1.6**
N-retention, g/d	29.2	14.2	19.1	19.5	2.0**

** $P<.01$

Key Words: Sheep, Soybean Hulls, Nitrogen Retention

293 The effects of diet on the acid-resistance of *E. coli* in feedlot steers.

C. J. Fu*[1], J. H. Porter[1], E. E. D. Felton[2], J. W. Lehmkuhler[3], and M. S. Kerley[1], [1]*University of Missouri-Columbia,* [2]*West Virginia University,* [3]*University of Wisconsin-Madison.*

Fifty four feedlot steers were used to determine the effects of diet on acid-resistance of fecal *E. coli*. Steers were fed an 85% corn-based diet for 90 d and then shifted to treatment diets for 5 d prior to slaughter. The four treatment diets were: 1) 85% corn-based diet; 2) 85% soybean hull-based diet; 3) 100% hay diet; and 4) the 85% corn-based diet with a three-fold elevated level of calcium carbonate. Fecal samples were collected from each steer before dietary shift and 5 days after dietary shift. Acid-resistance was expressed as viability after acid-shock at pH 2.0 for 1 h for fecal *E. coli*. Petri-film (3M, Petrifilm, St. Paul, MN) was used to enumerate fecal *E. coli*. The *E. coli* O157:H7 was not found in fecal samples. The fecal *E. coli* viability decreased ($P < 0.05$) only in the hay group and increased ($P < 0.05$) in the elevated Ca group. The hay group and high Ca group also had decreased ($P < 0.05$) and increased ($P < 0.05$) VFA (acetate, propionate, and butyrate) concentration in the feces after dietary shift, respectively. The fecal pH was marginally increased in the hay group. This study indicated that acid-resistance of *E. coli* could be induced by VFA and possibly Ca levels even though the environmental pH was near neutral. Further research is needed to determine if dietary calcium concentration can influence development of acid-resistance.

Key Words: *E. coli*, Acid-resistance, Steer

294 Effect of degradable protein concentration on organic acid production by mixed rumen bacteria.

C.A. Willis*, L.R. Legleiter, and M.S. Kerley, *University of Missouri-Columbia.*

Feeding strategies have been developed that allow feeding roughage free diets to beef cattle by modifying intake behavior. Our hypothesis is that control of acid production in the rumen can be manipulated to alleviate the need of roughage without intake modifications. Two experiments were conducted to determine the relationship between dietary degradable protein and VFA production. A pilot experiment was designed to test if calf growth performance was affected by absence of roughage and level of rumen degradable protein (RDP) in a feedlot diet. Sixty heifers (5/pen) were fed one of four diets. Diets were corn-based with 1) soybean meal (SBM) plus 15% hay (SBM-H), 2) bloodmeal (BM) plus 15% hay (BM-H), 3) BM with 0% hay (BM), and 4) SBM with 0% hay (SBM). Feed intake was monitored by orts and body weight was measured on day 1, 28, and 56. Average daily gain and feed:gain of heifers fed SBM-H, BM-H and BM were 3.0, 2.8, 2.2, 7.4, 7.0, and 6.6. The SBM treatment was stopped due acidosis. It was concluded that roughage can be removed from a diet and result in improved feed efficiency, but with decreased daily gains. The volume of fecal output for the BM treatment was reduced compared to hay diets. A batch culture was conducted to compare 5 diets of differing RDP level to determine if excessive RDP promoted lactic acid production. Diets consisted of 1) 4% 2) 4% 3) 9% 4) 15% and 5) 28% RDP. Urea was added at 1% of the diet for treatments 2 thru 5to ensure an adequate ammonia-N source

for microbial growth. The basal diet was ground corn with SBM as the RDP source. As RDP level increased (P<0.01) starch fermentation rate increased. Lactic acid concentration was different (P<0.03) among diets, however, it did not increase as RDP increased. VFA concentration was greater (P<0.01) at higher levels of RDP. It was concluded that total acid load was more important than lactic acid production. Further understanding of factors controlling rate of gain and feed intake is needed.

Key Words: Rumen Undegradable Protein, Volatile Fatty Acid

295 Effects of management on the voluntary dry matter intake and dry matter digestibility of tall fescue hay. J. E. Turner*, W. K. Coblentz, K. P. Coffey, R. T. Rhein, B. C. McGinley, N. W. Galdamez-Cabrerra, C. F. Rosenkrans, Jr., D. W. Kellogg, and J. V. Skinner, Jr., *University of Arkansas*.

Relatively little is know about the effects of spontaneous heating and natural rainfall on the feeding value of tall fescue (Festuca arundinacea Schrieb.) hay. A digestion trial utilizing a 4 × 4 latin square design was initiated to determine the effects of management before baling on the voluntary DMI, OM and DM digestibility, in situ disappearance kinetics, and ruminal fermentation parameters of tall fescue hay consumed by steers (average initial BW = 226.8 kg). The four tall fescue hays utilized in this experiment were harvested on the same date and baled at either 9.9 (low, L), or 22.5% (high, H) moisture prior to rainfall, or at 24.6% moisture after a 2.26-cm rainfall event (HR, or at 9.3% moisture after an accumulation of 7.07-cm of rain (LR)over a seven day period. Voluntary DMI of hay and the total diet were greater ($P < 0.05$) for steers consuming the non-rain damaged hays than for those fed the HR hay. However, digestibilities of DM, OM, ADF, and NDF were greater ($P < 0.05$) for steers consuming the HR hay than for those fed the non-rain damaged hays. In situ disappearance kinetics of both DM and N indicated that the Effective ruminal degradabilities of the HR and LR hays were lower ($P < 0.05$) than either the H or L hays. Hays baled prior to rain-damage had greater ($P < 0.05$) proportions of DM, NDF, and N that were immediately soluble in the rumen than did the hays that received rain-damage prior to baling. Concentrations of rumen ammonia increased ($P < 0.05$) between feeding and 2 h, and then decreased during the subsequent 10 h. Therefore, rain damage can reduce the voluntary intake of hay. Although rain-damaged hays may have inherently lower effective ruminal degradation than non rained-on hays, these differences can be masked by reduced intakes and subsequent potential reductions in rates of passage.

Key Words: Tall Fescue, Rain Damage, Intake

296 Thyroid hormone concentrations in the neonatal calf. J.E. Rowntree*, D.R. Hawkins, G.M. Hill, R.F. Nachreiner, J.E. Link, M.J. Rincker, and R.A. Kreft Jr., *Michigan State University*.

Thyroxine (T_4) is deiodinated by type 1 iodothyronine deiodinase, a Se requiring enzyme, to form triodothyronine (T_3). One role of T_3 is temperature control via uncoupling protein 1 (UCP1) in brown adipose tissue (BAT) of neonatal calves. Typically BAT is mobilized in cattle during the first week of life. Cold temperatures coupled with Michigan's low Se status, increases the potential for diminished T_3 activation of BAT thermogenesis in neonatal cattle. Therefore, our objective was to monitor thyroid hormone variables in newborn Holstein heifer calves (n = 8) for 7 d during the winter. Initial blood samples were obtained when calves were < 12 hr of age and daily thereafter. Calves were administered 1 mg of selenium as sodium selenite and 68 IU vitamin E as d-alpha tocopheryl acetate (BO-SE, Schering-Plough, Kenilworth, N.J.) following the initial bleeding. On d 2, calves were placed in individual hutches located in an open front pole barn for the remainder of the trial. The mean concentration of T_4 on d 1 was 156 nmol/L, which declined to 71 nmol/L on d 7 ($P < 0.01$). The mean concentration of T_3 on d 1 was 6 nmol/L, which was reduced to 2 nmol/L on d 7 ($P < 0.01$). The T_3:T_4 ratio on d 2 was 0.045 and declined to 0.032 by d 7 ($P < 0.01$). The mean ratio of T_3: reverse triiodothyronine (rT_3) was lowest ($P < 0.01$) on d 1 and peaked on d 3 (2.16 and 4.67, respectively) indicating improved conversion of T_4 to T_3. These initial data indicate that age and/or Se injection may alter T_3:T_4 and T_3:rT_3 ratios in neonatal calves. However, data do not reveal which variable(s), Se or age, influence(s) thyroid hormone concentrations.

Key Words: Thyroid hormones, Selenium, Cattle

297 Performance of feedlot heifers fed corn silage or brown midrib forage sorghum silage as the roughage portion of a finishing diet. B. Hough*[1,2], L. W. Greene[1,2], F. T. McCollum, III[3], B. W. Bean[1,3], N. A. Cole[4], and T. Montgomery[2], [1]*Texas Agricultural Experiment Station, Amarillo,* [2]*West Texas A&M University, Canyon,* [3]*Texas Cooperative Extension, Amarillo,* [4]*USDA-ARS, Bushland*.

One hundred twenty six crossbred heifers (average BW=315 kg) were used to determine the performance of heifers fed brown midrib forage sorghum silage (BMRS) vs. corn silage (CS) as the roughage source in a finishing diet. Silage was stored in 4.5 m diameter silage bags. Heifers were blocked by weight and previous grazing program, and randomly assigned to one of three diets, 10% (DM basis) CS (C10), 10% (DM basis) BMRS (S10), and 7.5% (DM basis) BMRS (S7.5) in a randomized block design. Other diet ingredients consisted of steam flaked corn, choice white hog grease, and supplement. Diets were formulated to include CS and BMRS at equal levels of DM inclusion (C10 vs. S10), and equal NDF concentrations (C10 vs. S7.5). Heifers were housed in 18 pens (n = 7/pen), and fed in fence-line bunks. Carcass characteristics were determined after harvest. Heifers fed either the S10 or S7.5 diets gained 11.3% faster ($P < 0.03$) than those fed C10 (1.38 and 1.38 vs. 1.24 kg/d, respectively). Feed intake (8.5, 8.8, and 8.7 kg/d for C10, S10 and S7.5, respectively) was not different ($P = 0.43$) across treatments. Gain efficiency (gain/intake) was greater ($P < 0.01$) for heifers fed S10 and S7.5 compared to those fed C10 (0.158 and 0.158 vs. 0.148, respectively). Heifer performance was not different ($P > 0.10$) for heifers fed S10 vs. S7.5. No differences in carcass characteristics were detected ($P > 0.10$). Due to storage of the silages, the CS contained noticeable mold on the face of the silage when feeding which may have affected subsequent heifer performance. Results indicate that BMRS as a roughage source will not affect performance of heifers fed a high concentrate finishing diet when compared to those fed CS.

Key Words: Heifer, Corn Silage, Sorghum Silage

298 Digestibility of sunflower screenings by beef cows. K. P. Ladyman*[1], J. H. Porter[1], and M. S. Kerley[1], [1]*University of Missouri-Columbia*.

The objective of this study was to determine the nutritional value of sunflower screenings (SS) as a feed by-product for beef cattle. Three cannulated (rumen) beef cows (averaging 653 kg ± 14 kg) were used in a replicated 3 X 3 Latin square design to determine nutrient digestibility. The cows were fed three different rations consisting of: (1) 100% hay, (2) 80% hay and 20% SS, or (3) 60% hay and 40% SS. The hay was a medium quality alfalfa/grass mixture. The sunflower screenings were generated from a birdseed cleaning operation. Feed ingredients and feces were analyzed for dry matter (DM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), ether extract (EE), and acid detergent lignin (ADL). Acid detergent lignin was used as the marker to calculate nutrient digestibility. The nutrient composition of sunflower screenings was: DM 90%, CP 12.7%, NDF 75.4%, ADF 62.9%, and EE 10.7%. The cows were penned individually under roof with seven days of acclimation followed by three days of collection for each treatment and then rotated to a different ration. As compared to the hay, SS in the diet reduced DM digestibility by 17%. The apparent digestibility of CP was 21.5% lower and the digestibility of NDF and ADF was 7 and 18% higher, respectively, for SS. The SS contained 10.7% EE which was highly digested. The hay had a relative feed value of 78.4 and an estimated total digestible nutrient value of 47.3%. The energy value of SS was estimated to be approximately equivalent to the hay fed in this experiment.

Key Words: Sunflower Screenings, Digestibility, Feed By-product

299 Nutritive value of crabgrass harvested on seven dates in Northern Arkansas. R. K. Ogden[1], W. K. Coblentz*[1], K. P. Coffey[1], J. E. Turner[1], D. A. Scarbrough[1], and J. A. Jennings[2], [1]*University of Arkansas, Fayetteville, AR,* [2]*Cooperative Extension Service, Little Rock, AR*.

Common crabgrass is often viewed as an unwanted weed in lawns, pastures, and hay meadows. Because it dries slower than bermudagrass, producers selling hay to the equine industry are especially concerned

about infestations of crabgrass in stands of bermudagrass. However, visual observation and circumstantial evidence indicate that cattle prefer crabgrass to many other summer forages, and often exhibit good summer performance when consuming this forage. Common crabgrass was harvested weekly between July 11 and August 22, 2001 in order to assess the nutritive value of leaf, stem, and wholeplant tissues. The percentage of leaf in the sward declined in linear ($P < 0.0001$), quadratic ($P = 0.0003$), and cubic ($P = 0.032$) patterns over this time period, ranging from a high of 46.6% on July 11 to a low of 28.4% on August 8. Generally, fiber components (NDF, ADF, hemicellulose, cellulose, and lignin) in whole-plant tissue increased in linear ($P = 0.013$) patterns over sampling dates; however, the maximum NDF and ADF were only 61.9 and 31.3%, respectively. Concentrations of NDF ranged from 48.7 to 54.6% for leaf tissue and from 57.0 to 64.2% for stem tissue over the sampling period. Concentrations of N in wholeplant tissue declined linearly ($P = 0.001$) from 3.36 to 2.55%; between 23.7 and 38.9% of this N was associated with the cell wall, and this fraction increased in linear ($P < 0.0001$) and cubic ($P = 0.006$) patterns over time. On a whole-plant basis, concentrations of ADIN increased over time in linear ($P = 0.049$) and quartic ($P = 0.046$) patterns, exhibiting a maximum of 7.58% of total N on the August 15 sampling date. For leaf and stem tissue, concentrations of N decreased linearly ($P = 0.002$) over time, but were generally higher in leaf tissue than in the associated stem. However, the percentage of total N associated with the cell wall ranged from 29.6 to 45.0% for leaf tissue, but only 20.2 to 30.8% for the associated stem. Crabgrass appears to have good nutritive value and to offer considerable promise as a forage alternative during the summer months in the upper South.

Key Words: Crabgrass, Nutritive Value, Summer Forage

300 Corn crop residue grazing effects on soil physical properties and soybean production in a corn-soybean crop rotation. J.T. Clark*[1], J.R. Russell[1], D.L. Karlen[2], W.D. Busby[1], D.L. Maxwell[1], and B. Peterson[3], [1]*Iowa State University, Ames, IA,* [2]*USDA-NSTL, Ames, IA,* [3]*USDA-NRCS, Creston, IA.*

Over 3 yr, two 19.4-ha fields near Atlantic, IA were divided into four blocks with 6 paddocks to evaluate the effects of corn crop residue grazing by beef cows on soil characteristics and soybean yields. Three beef cows were allotted to each block to graze five of the paddocks at 28-d periods starting mid-October. Twelve grazing exclosures were placed in two transects within each grazed paddock. Precipitation and soil temperature were measured daily and soil bulk density, moisture and clay contents, penetration resistance, surface roughness, and corn crop residue cover was measured at the termination of grazing in the spring. Soil bulk density, moisture content, and penetration resistance in grazed paddocks were measured inter-row to a depth of 20.3 cm inside and approximately 5 m outside grazing exclosures and expressed as the outside-to-inside ratio. In the subsequent growing seasons, soybeans were planted in replicate fields with disking or no tillage and yield determined at harvest. Compared to ungrazed paddocks, penetration resistance ratio was greater ($P<0.05$) in the second paddock grazed for all three years and greater ($P<0.05$) in the first and last paddock grazed in yr 2 and 3. Compared to the ungrazed paddocks, post-grazing crop residue cover was lower ($P<0.05$) in the first two paddocks grazed in yr 2 and for all paddocks grazed in yr 3. In yr 2, post-planting crop residue cover in blocks planted with no tillage were lower ($P<0.05$) in the second, fourth, and fifth paddocks grazed than the ungrazed paddocks. Soil surface roughness was greater ($P<0.05$) in the third and last paddocks grazed in yr 1 and in the second and last paddocks grazed in yr 2 than ungrazed paddocks. Bulk density ratio, post-planting crop residue cover in disked blocks, and soil clay contents were not different from ungrazed paddocks over the 3 yr. Soybean yields did not differ between grazed and ungrazed paddocks in the first two seasons measured.

Key Words: Corn Crop Residue, Grazing, Soil

301 Influence of prior nutritional treatment on residual feed intake as an indicator of efficiency. C. L. Ferrell*, T. G. Jenkins, and H. C. Freetly, *USDA-ARS, U.S. Meat Animal Research Center.*

Objectives were to evaluate prior treatment effects on residual feed intake (RFI), an indicator of efficiency in beef steers. ADG, daily DMI, feed/gain (FPG), and residual ADG (RADG) were also evaluated as indicators of efficient steers. Simmental × MARC III steers (358±3.0 kg) were individually fed a diet (80% corn, 13.61% corn silage, 4.40% soybean meal, 0.78% urea, 0.67% limestone, 0.43% dicalcium phosphate, 0.09% salt, 0.008% trace mineral premix, and 0.015% monensin premix; dry basis) in pens of six. Twelve steers were assigned to each of eight preliminary treatments: 40, 50, 60, 70, 80, 90, 100, or 110 g × $kg^{-0.75}$ × d^{-1} for 112 d. Steers were weighed at 14 d intervals, and feed allotments were adjusted at those times. All steers were fed ad libitum until slaughter during the ensuing experiment which consisted of 74 d for steers fed at the 40-70 levels and 39 d for steers at the 80-110 levels during the prior period. Steers were slaughtered at a commercial facility and carcass data was collected. Initial weight (IWT), final weight (FWT) and ADG were calculated from regressions of weight on time for each steer. Similarly, DMI was calculated from cumulative feed consumed on time for each steer, and FPG was calculated. Residual feed intake was determined as the residual from the regression of DMI on IWT and ADG, and RADG was determined as the residual from the regression of ADG on IWT and DMI. Prior treatment influenced IWT ($P<0.001$), FWT ($P<0.001$), ADG ($P<0.001$), DMI ($P=0.047$), FPG ($P<0.001$), RFI ($P=0.041$), and RADG ($P=0.053$). Means (± SD) for these traits were 469 (55), 566 (39), 1.69 (0.33), 10.00 (1.31), 6.15 (1.52), 0.00 (1.04), and 0.00 (0.27), respectively. Five steers (of 93) identified as efficient based on low RFI had 14 kg greater IWT, 1.86 kg/d lower DMI, 0.32 kg/d lower ADG than the mean, whereas steers identified by RADG had 18 kg greater IWT, 0.04 greater DMI, and 0.41 kg/d greater ADG. These results suggest potential negative consequences of selecting solely on RFI and that RADG may be a viable alternative.

Key Words: Efficiency, RFI, RADG

302 The degradative properties of soybean proteins. W.H. Kolath* and M.S. Kerley, *University of Missouri - Columbia.*

The objective of this study was to explore the degradative properties of soybean proteins in the rumen. A crude enzyme extract was prepared by isolating the bacteria in rumen fluid using differential centrifugation and disrupting those bacteria with a French press cell. Crude enzyme extract (3mL)was then incubated with 30mL of solubilized soybean protein for 48 hours. The soybean protein was found to be 90% soluble in Mcdougal's buffer. Samples were taken every 4 hours to determine which protein subunits were able to resist degradation and SDS-PAGE was performed to determine the disappearance of each individual subunit. Alpha and alpha prime conglycinin (molecular weight 75,000 and 72,000) were completely degraded to smaller peptides (molecular weight less than 68,000) after 8 hours of digestion with alpha conglycinin being completely digested after 4 hours. The beta subunit of conglycinin was almost completely degraded at 24 hours, with the acidic subunit of glycinin disappearing by 28 hours. The basic subunit of glycinin was the most resistant to degradation with a slight amount remaining at 48 hours. An in situ was also performed to determine if the rate and extent of digestion seen with the crude enzyme extract was similar to what occurred in the rumen. Soybean meal (3g) was sealed in in situ bags and placed in the rumen for 0, 6, 12, 24, 48 and 72 hours. After 48 hours less than 3% of the initial soybean meal placed in the bags remained. The in situ loss of soybean protein closely matched what was observed by using the crude enzyme extract to digest the protein. Therefore, the genetic selection for soybean proteins with greater amounts of basic glycinin may increase the rumen undegradeable protein value of soybean meal.

Key Words: Soybean, Degradation, In situ

303 Effects of metabolic acid-base disturbance caused by cation anion intake on performance of heifers before and during transition to a high concentrate finishing diet. J. J. Williams*[1] and L. W. Greene, [1]*Texas A&M University Research and Extension Center.*

The effects of metabolic acid-base disturbance caused by cation anion intake (DCAD) on performance of heifers during transition to a high concentrate diet were determined in 2 experiments. In Exp 1, 24 crossbred heifers (245.5 kg), were blocked by weight and assigned to 3 high roughage DCAD diets, low (L) low+limestone (LL) and high (H). Heifers fed the LL diet received 0.80% dietary limestone during the transition period in the high concentrate diet. L and LL contained -99 mEq/kg and H contained +247 mEq/kg of DM calculated as ($Na^+ + K^+ + 0.38Ca^{2+} + 0.3Mg^{2+}$) - ($Cl^- + 0.6S^{2-} + .5P^{3-}$). The L and LL diets were prepared by the addition of NH_4Cl to the diet. By d 7 of feeding

the anionic diets, urine pH was lower ($P < 0.05$) for heifers fed L and LL. From d 21 to 35 urine pH for heifers fed L and LL increased from 5.58 and 6.45 to 7.57 and 7.59, respectively. This response was presumably due to an increased ruminal fluid dilution rate caused by intake of added dietary salts. On d 10, 20 and 35 blood pH was lower ($P < 0.05$) for heifers fed L and LL compared to heifers fed H. During the transition period no difference in DMI was observed between H and L or LL. In Exp 2, heifers from Exp 1 were fed a high roughage diet, reallocated to treatments on d 10, and provided NH_4Cl in drinking water instead of the diet to prevent a dilution by increased water intake. L and LL heifers were given ad libitum access to water containing NH_4Cl (0.007 kg/liter) for 7 d (d 11 to 17). By d 12, urine pH was lower ($P < 0.05$) for L and LL than for H and remained lower until d 20. On d 17 blood pH and HCO_3^- were lower ($P < 0.05$) for L and LL than for H. By d 23 blood pH and HCO_3^- was not different ($p > 0.05$) for any treatment. DMI during the transition to a high concentrate diet (d 18 to 33) was 8.07, 8.49 and 9.15kg for L, LL and H, respectively (P=0.46). This data suggests that cattle consuming anionic diets prior to transition to a high concentrate diet are not any more susceptible to acidosis than those fed cationic diets.

Key Words: DCAD, Acidosis, Rumen

304 Effect of supplementation and advancing gestation on intake of low-quality forage.

T. W. Loy*, D. C. Adams, T. J. Klopfenstein, and J. A. Musgrave, *University of Nebraska, Lincoln*.

Eighteen spring-calving heifers (406.7 kg, SD = 30) were used to determine the effects of advancing gestation and supplementation on intake of low-quality forage. Heifers were rectally palpated and paired based on expected calving dates. Each pen was assigned randomly to one of two supplement treatments; one high in undegradable intake protein (UIP; n = 4), and one based on dry corn gluten feed (DCGF; n = 5). Supplements were formulated to meet metabolizable protein requirements. Average supplement DMI was 0.7 and 2.6 kg / d for UIP and DCGF, respectively. Heifers were given ad libitum access to upland and meadow hays, combined to be reflective of the protein and energy content of grazed winter range. Intakes were measured weekly. The trial began Dec 18 and concluded May 7. Treatments were applied prior to calving (March and April). After calving, heifers were fed a common diet. Weight and body condition score (BCS) were recorded on two consecutive days at the beginning and end of the trial, and at 28 d intervals throughout. Milk intake (MI) was determined at the end of the trial using 12-h weigh-suckle-weigh. Calf birth weights and ADG from birth to May 7 were recorded. Data were analyzed as repeated measures using the mixed procedure of SAS. Initial weight did not differ($P = 0.58$) by treatment. Heifers in the UIP treatment lost 24.6 kg over the course of the study, compared to 1.3 kg for DCGF ($P = 0.02$). Treatment did not affect ($P = 0.41$) initial BCS (5.2) or BCS change (-0.2). Calf birth weight, MI, and ADG were not affected ($P > 0.12$) by treatment. Forage intake was not affected ($P = 0.43$) by supplement, and no time x supplement was detected ($P = 0.98$). Intake changed quadratically ($P < 0.01$) with respect to calving. Maximum forage DMI was 12.5 kg three weeks prior to calving. Intake at calving fell to 10.3 kg, and increased to 12.0 kg two weeks after calving. Providing energy in non-bulky form to heifers in late gestation may help alleviate effects of depressed intake of low quality forage.

Key Words: Intake, Gestation, Supplementation

305 Effects of RUP inclusion level on ruminal degradability of RUP.

L. R. Legleiter* and M. S. Kerley, *University of Missouri, Columbia, MO*.

This experiment was designed to test the effect of protein inclusion rate on ruminal protein degradation and the subsequent RUP value. Twenty-four dual flow continuous culture fermentors were used in conjunction with 4 dietary treatments and one control diet. The five diets were basal (B) with no supplemental protein, basal + 2.5% blood meal (BM-L), basal + 5% blood meal (BM-H), basal + 4.45% soybean meal (SBM-L) and basal + 9.98% soybean meal (SBM-H). BM-L and SBM-L were formulated to be isonitrogenous; likewise, BM-H and SBM-H were isonitrogenous. The experiment consisted of two 10-d experimental periods including a 7-d acclimation period followed by 3-d of sampling for each period. Fermentor dilution rates were held constant at 4.5%/hr for all treatments. The treatments were fed at a rate of 60g/d throughout the experimental period. Ammonia concentration was not different (P>0.05) between BM-L and BM-H, but increased (P<0.05) from 3.84 mM for SBM-L to 7.44 mM for SBM-H. Microbial efficiency (g of N/ kg OM truly digested) was not different (P>0.05) for BM-L vs BM-H or for SBM-L vs SBM-H with efficiencies of 19.47, 22.07, 21.9 and 23.64 respectively. Proteolytic activity was not different (P>0.05) between the two levels of protein sources with micrograms of Azocasein degraded/hr/mg of sample averaging 115.9, 129.5, 132.9 and 157.6 for BM-L, BM-H, SBM-L and SBM-H respectively. The VFA production and peptide concentration was not affected (P>0.05) by level of protein source. The % RUP of BM-L was not different (P>.05) from the % RUP of BM-H with values of 49.2% and 55%, respectively. Likewise, the % RUP was not different (P>.05) for SBM-L at 44.6% and SBM-H at 39.3%. These data suggested that increasing dietary inclusion rate of an RUP source from 2.5% to 5% did not significantly decrease the % RUP of the protein source.

Key Words: Bloodmeal, RUP, Continuous Culture

306 Effect of supplement type and degradable intake protein addition in diets for lactating beef cows.

T. A. Baumann*, G. P. Lardy, W. W. Dvorak, and V. Anderson, *North Dakota State University, Fargo, ND*.

A 2 x 2 factorial design was used to determine the effect of supplement type (corn vs soyhulls) and protein addition (with or without) to a medium quality forage diet for lactating beef cows. Cow/calf pairs (n = 78; 610.5 ± 3.4 and 90.8 ± 1.5 kg initial BW; cows and calves, respectively) were used in the study. A basal diet consisting of 75% grass hay (11.5% CP, 65.9% NDF, and 40.1% ADF) and 25% wheat straw (7.4% CP, 75.9% NDF, and 50.2% ADF; DM basis) was fed from May 16 (43 ± 10 d post-partum) to September 6. Cows were stratified by calving date and BW and assigned randomly to treatment. Supplemental treatments and predicted DIP balances were 4.78 kg dry rolled corn (-415 g/d); 5.32 kg soyhulls (SH) (-260 g/d); 3.68 kg dry rolled corn plus 1.55 kg sunflower meal (-0.02 g/d); or 4.50 kg SH plus 1.05 kg sunflower meal (-0.02 g/d). Diets were formulated to provide 20 Mcal/d NE_m. Cow BW, body condition score (BCS), milk yield, and calf BW were recorded at d 1, 28, 56, 84, and 112 for all response variables except milk yield which was not recorded at d 1. Data was analyzed as a split plot in time with pen as the experimental unit. No interaction between grain source and addition of protein was present ($P = 0.33$) nor was there an interaction between treatment and period ($P = 0.91$) for any response variable. Therefore, the main effects of treatment and period are discussed. Grain source and addition of protein had no effect ($P > 0.16$) on cow BW, BCS, milk yield, or calf BW. Cow BW decreased ($P < 0.001$) from 610.5 to 584.2 ± 3.4 kg during the study. BCS decreased ($P < 0.001$) from 5.58 on d 1 to 5.01 ± 0.05 on d 112. Milk yield declined ($P < 0.001$) from 13.1 kg on d 28 to 7.7 ± 1.1 kg on d 112. Calf BW increased ($P < 0.001$) from 90.8 to 219.6 ± 1.5 kg during the 112 d trial. In summary, no differences due to supplement type or protein addition were noted for BW, BCS, milk yield, and calf BW. Therefore, corn or SH are suitable as a supplement for the quality of forage utilized in this trial. Addition of supplemental protein did not improve cow or calf performance.

Key Words: Digestible Fiber, Starch, Soyhulls

307 A dehydrated mixture containing food waste and wheat middlings serves as a protein and energy substitute in beef cow diets.

P.M. Walker*[1] and A.D. Antas[1], [1] *Illinois State University, Normal, IL/USA*.

Three trials utilizing 222 crossbred beef cows were conducted over three years to evaluate the efficacy of replacing a portion of the diet with a dehydrated mixture containing wheat middlings and ground food waste (DF) from retail grocery stores. In trial 1 (T1), trial 2 (T2) and trial 3 (T3) 78, 73, and 71 beef cows in their second and third trimesters were blocked by parity (first parity vs. two or more parities), then allotted to treatment pens according to body condition, subject to variation in body weight. The duration of T1, T2, and T3 were 143, 184, and 155 days, respectively. Trials were terminated each year following a timed insemination to a synchronized estrus. Control (CTL) cows were fed a corn silage-shelled corn-soybean meal based diet according to NRC estimates. Treatment (TRT) cows received diets similar to CTL except DF replaced all of the soybean meal and corn. Chemical analysis

found DF to contain 88.3±8.9% DM, 19.6±13.3% ADF, 19.0±17.0% cellulose, 4.2±0.5% ADL, 0.19±0.1% AIA, 18.5±3.3% CP, and 5.7±2.1% EE. During T1, T2, and T3, EE values were higher and CP values were lower (P<0.05) for TRT than CTL diets. No significant differences were observed for cellulose, ADF, ADL, Ash, DM and AIA for T1, T2, and T3 between TRT and CTL diets. No significant differences in daily corn silage consumption nor in ADFI were observed between TRT and CTL cows. The mean DF intake for TRT cows as a percent of diet (wet weight basis) was 11.1%. Mean body weight changes and body condition score changes were similar between TRT and CTL cows. Mean calf weight at the end of each trial and mean calf ADG were similar between TRT and CTL cows. Percent calf crop saved at birth, subsequent percent calf crop weaned and cow conception rates (chi-square = 1.61) were not different (P>0.05) between TRT and CTL cows. Milk production (24 h estimated production)was higher (P<0.05) for TRT than CTL cows but no significant differences were determined for milk fat or milk protein percents. The calculated feed replacement value for DF for this study was 11.04:kg. The data of this study suggests that DF can serve as an alternative feedstuff in diets of beef cows.

Key Words: Feedstuff, Cows

308 Effect of low-level fall protein supplementation on the performance of beef cows grazing tallgrass-prairie range. D. A. Llewellyn*, R. C. Cochran, T. T. Marston, D. M. Grieger, C. G. Farmer, and T. A. Wickersham, *Kansas State University, Manhattan*.

An experiment was conducted to evaluate the effect of providing a limited quantity of a high-protein supplement during the fall grazing period on cow and calf performance. Time of initiation of supplementation was also examined. One hundred-thirty six multiparous, pregnant, spring-calving cows grazing native range were assigned to supplementation treatments in a randomized complete block design. Twelve pastures were used providing four replications per treatment. Control (CTRL) cows received no fall supplementation. Supplemented cows received .68 kg/d of a high-protein supplement (40% CP, as-fed basis) approximately 2 mos pre- and post-weaning (PRPO; 8/15 to 12/14; weaning = mid-October) or only post-weaning (POST; 10/15 to 12/14). Supplement was fed 3 d/wk (prorated to deliver designated daily amount). All cows received 1.8 kg/d of the same supplement during the winter (12/14 to calving; calving = early March). Through weaning, PRPO cows gained more (P=0.03) body weight (BW); body condition score (BCS) followed a similar trend (P=0.16). Both PRPO and POST had greater (P=0.02) increases in BCS and BW compared with CTRL over the entire fall period; although PRPO and POST were not significantly different in the period from weaning until the beginning of winter supplementation. Cows supplemented during fall had slightly greater (P=0.05) cumulative BW change through calving, although BCS change was not different (P=0.30) among treatments. Calf birth weights were not significantly different among treatments. Calves from PRPO cows gained BW more rapidly (P=0.02) from birth through the start of the grazing season than those from POST cows, and the average of calves from PRPO and POST was greater (P=0.03) than for CTRL calves. In conclusion, feeding beef cows a limited amount of a high-protein supplement during the fall and the length of the supplementation period affected cow BW and BCS changes and, in some cases, subsequent calf performance.

Key Words: Protein, Beef Cattle, Supplementation

309 Effect of rumen degradable protein source on forage intake, digestion, and ruminal kinetics in beef steers fed low-quality hay. W. W. Dvorak*, M. L. Bauer, G. P. Lardy, and J. S. Caton, *North Dakota State University, Fargo*.

Four ruminal and duodenally cannulated beef steers (417 ± 87 kg initial BW) were used in a 4 x 4 Latin square to evaluate effects rumen degradable protein (RDP) source on intake, ruminal fermentation, site of digestion, and microbial protein synthesis. Steers had ad libitum access to low-quality cool-season grass hay (6.4% CP, 68.3% NDF, DM basis) that was offered twice daily. Treatments were control (C; corn-based supplement), urea (U; NPN), steep liquor (L; amino acids and peptides), and sunflower meal (S; intact protein) based supplements. Supplements were fed daily at 0.237, 0.273, 0.269, and 0.295% of BW on DM basis for C, U, L, and S, respectively. Urea, steep liquor, and sunflower supplements were formulated to have a RDP balance of 0 according to the 1996 NRC model and all treatments supplied equal NE. There were no differences ($P > 0.10$) in DM or OM intake between RDP and C treatments. Treatments supplemented with RDP had increased ($P = 0.08$) duodenal microbial OM flow. Control treatment tended ($P = 0.12$) to have decreased intestinal OM disappearance (OMD) compared with RDP treatments. RDP supplementation increased (59 vs 53 ± 2%; $P = 0.02$) total tract CP disappearance (CPD) compared with C. Also, RDP supplementation tended ($P = 0.15$) to increase apparent digestion rate of CP and NDF as a percentage of rumen fill. Supplementation with L and S increased ($P < 0.02$) intake of all nutrients compared to U. Supplementing L and S increased (4.9 vs 4.6 ± 0.1 kg/d; $P = 0.10$) OMD in stomach and bacterial CP flow ($P = 0.01$) compared to U. In situ forage DM disappearance (DMD) and NDF disappearance (NDFD) was increased ($P < 0.04$) by RDP supplementation compared to C. Supplementation with L and S increased ($P < 0.02$) in situ forage NDFD, neutral detergent insoluble crude protein disappearance and tended to increase ($P = 0.12$) DMD. Data suggests that supplemental RDP enhances ruminal kinetics and utilization of protein deficient hay consumed by beef steers.

Key Words: Rumen Degradable Protein, Protein Supplementation, Ruminal Kinetics

310 Use of *Ascophyllum nodosum* for alleviation of heat stress in cattle. L.N. Thompson*[1], J.E. Williams[1], K.J. Barnhart[1], L.E. McVicker[1], D.E. Spiers[1], and D.P. Colling[2], [1]*University of Missouri, Columbia, MO,* [2]*Acadian Seaplants, Inc.*.

A study was conducted to evaluate the influence of *Ascophyllum nodosum* (Tasco meal) on core body temperature and in situ DM disappearance in cattle exposed to elevated ambient temperature. Twenty-four steers (avg. wt. = 300.6 kg) were randomly assigned to treatments: 1% Tasco meal (TM) vs no Tasco Meal (NT), thermoneutral (TN) vs heat load (HL) conditions. The steers were placed in one of four environmental chambers, maintained initially at TN (19C), with 3 steers in each room assigned to TM vs NT. Prior to the study, steers were ruminally cannulated (n=8) and telemetric transmitters (n=24) installed in the peritoneal cavity. For 7 d, steers were acclimated to chambers at TN and remained at TN through period 1. Prior to 0700 h, steers were fed treatment pre-mixes of ground corn / alfalfa meal + 1% TM or NT. At 0700 h, steers were fed a cottonseed hulls / cracked corn diet (12.6% CP; 30.8% ADF) ad libitum. During periods 2, 3, and 4 (all 10 d), 2 chambers were maintained at TN. For period 2, HL chambers were maintained at 36C daytime high with nighttime low of 19C. For period 3, HL was maintained at 36C and nighttime low at 31C. For period 4, the TN and HL treatments were reversed. An in situ study was conducted to measure DM disappearance during each period. Core body temperature, DM intake and ADG were recorded for each period. Steers exposed to elevated ambient temperature had decreased ($P < 0.05$) DM intake and ADG. The TM had no affect ($P > 0.05$) on DM intake or ADG. The steers exposed to elevated temperature had higher ($P < 0.05$) core body temperature than the TN treatment; for period 2, TM appeared to lower core body temperature ($P < 0.20$) for HL treatment compared to NT. A treatment by temperature interaction ($P < 0.05$) revealed that TM increased in situ DM disappearance as compared to NT under HL. In conclusion, Tasco Meal had short-term effects on lowering core body temperature as well as enhancing in situ DM disappearance in cattle exposed to heat stress.

Key Words: Tasco Meal, Heat, DM Disappearance

311 Effect of interseeding lespedeza versus additional nitrogen fertilization in a wheat-crabgrass double-crop system on forage production and cattle performance. L.W. Lomas*, J.L. Moyer, F.K. Brazle, G.L. Kilgore, and G.A. Milliken, *Kansas State University, Parsons*.

Grazing and subsequent finishing performance of steers that grazed a wheat-crabgrass double-crop system were evaluated in 1999, 2000, and 2001 to compare interseeding lespedeza with an additional application of N fertilizer. Ten 1.62-ha pastures were used in a completely randomized design with 5 replications per treatment. Hard red winter wheat was no-till seeded (119 kg/ha) in all pastures in the fall of 1998, 1999, and 2000, and 'Red River' crabgrass seed was broadcast (2.2 kg/ha) over all pastures in early spring of 1999, 2000, and 2001. Crabgrass had been grown on these pastures since 1997. 'Korean' lespedeza was no-till seeded (20 kg/ha) in five of the pastures in early spring of 1999, 2000, and 2001. All pastures received similar applications of fertilizer

except those pastures not seeded with lespedeza received an additional 56 kg of N/ha in mid-July of 1999, 2000, and 2001. Wheat grazing was initiated in mid to late March of each year. Following wheat graze-out, cattle remained on the pastures and grazed crabgrass from mid to late May until early September. Pastures were initially stocked with 3 steers/ha and stocking rate was reduced to 2.5 steers/ha at the end of the wheat grazing phase. Legume cover, forage dry matter production, grazing steer performance, and subsequent feedlot performance were measured. Available forage dry matter and grazing gains during the crabgrass phase were similar between pastures fertilized with additional N and those interseeded with lespedeza in all 3 years. In 1999, finishing gain and ribeye area were higher (P<.05) for steers that grazed pastures interseeded with lespedeza. In 2001, wheat grazing gain, overall grazing performance, finishing gain, and overall performance (grazing + finishing) were higher (P<.05) for steers that grazed pastures fertilized with additional N.

Key Words: Crabgrass, Lespedeza, Grazing

312 Protein requirements of bison bulls fed for meat.

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Dietary protein requirements of bison bulls fed for meat have not been determined. This study compared four crude protein (CP) levels (9.4, 11.6, 13.9, and 16.0%) fed to bison bull calves (n=80, avg. initial wt 287 5.37 kg) for 250 days prior to market. Canola meal (41% CP) was used as the protein source in the 75% concentrate rolled corn based diet that included chopped native grass hay as the forage. Bison were randomly assigned to one of eight pens (10 head per pen) and weighed individually at 90 day intervals. Totally mixed rations were fed to appetite once daily in fenceline bunks. Fecal samples were composited for each treatment using three fresh samples from each pen collected on weigh dates. Blood urea nitrogen (BUN) levels were determined using 5 additional bison calves fed the same CP diet treatments with sequentially higher CP levels offered at weekly intervals. Blood was sampled by veinipuncture at the end of each feeding period and serum analyzed for BUN. Data were analyzed using SAS GLM. Feed intake (7.82 kg) was not affected by protein level. Gain improved (P<.05) with increased CP in the diet. Bulls fed the 13.9% CP diet had the greatest daily gain during the first three months on feed (.91 kg) and overall (.90 kg). Lowest daily gains were observed from the 9.4 and 11.6% CP diets (.75 kg) with daily gains from the 16.0% CP diet intermediate (.79 kg). Feed efficiency was not affected (P>.10) by protein level (.10 units dry matter per unit gain). Fecal nitrogen was not different due to treatment (P>.10). BUN increased linearly (13.9, 16.0, 18.9, and 26.1 mg/dl) with increasing CP level (P<.05). Carcass traits used in the bison industry were not affected (P>.10) by CP level. While wild ungulates are known to recycle nitrogen more efficiently than domestic livestock, this data suggests bison will gain faster on higher levels of CP than commonly used by bison feeders.

Key Words: Bison, Protein, Requirements

313 Effects of advancing season on nutrient quality of alfalfa and black medic in southwestern North Dakota.

D. M. Oe*[1], G. P. Lardy[1], W. W. Poland[2], and P. Carr[2], [1]*North Dakota State University, Fargo,* [2]*Dickinson Research Extension Center, Dickinson.*

The objective of this research project was to characterize changes in nutrient quality of alfalfa (*Medicago sativa* L.) and black medic (*Medicago lupulina* L.) over a 9 week grazing season. Three replicate pastures of each forage species were established at the Dickinson Research Extension Center in southwest North Dakota. Each alfalfa pasture was split into three paddocks for the study. One paddock in each replicate pasture was clipped on June 10, 17, and 24, and then again on July 16, 22, and 29, such that each paddock was sampled once in June and once in July. Four random sites within each paddock were selected for each clipping date. Forage samples were clipped at ground level and samples were composited across site within paddock. A concurrent grazing trial was also conducted; samples collected in July were regrowth following grazing in June. The original protocol called for clipping each alfalfa and medic paddock on each sampling date. However, lack of forage growth in the black medic pastures prevented sampling until July 16. Samples were analyzed for DM, CP, NDF, ADF, and in vitro organic matter disappearance (IVOMD). Based on laboratory data, relative feed value (RFV) and net energy for lactation (NE_l) were also calculated. Because only six medic samples were collected, those data were not included in the statistical analysis. Data from the alfalfa paddocks were analyzed as a split-plot in time using the GLM procedures of SAS. Effects of sampling date (June vs July) were tested using replication by date as the split-plot error term. Significance was declared at $P < 0.05$. From June to July, NDF increased (39.7 vs 44.4%; $P = 0.008$), ADF increased (30.4 vs 34.1%; $P = 0.05$), while IVOMD decreased (70.4 vs 59.0%; $P = 0.009$). Net energy for lactation and CP tended to decrease (1.50 vs 1.41 Mcal/kg, $P = 0.052$; 18.4 vs 15.8%, $P = 0.08$). However, there was no difference in RFV (avg. $= 154 \pm 14.0$; $P = 0.21$). In conclusion, the nutritive quality of alfalfa decreased as season advanced. Unfortunately, problems with stand establishment for black medic prevented adequate sampling necessary to compare the two legume species in this pasture situation.

Key Words: Alfalfa, Season, Nutrients

314 Use of oat as a forage in dairy nutrition.

A.W.A.S. Abeysekara*, D.A. Christensen, J.J. McKinnon, and H.W. Soita, *University of Saskatchewan.*

Two studies were conducted to evaluate nutritional value of different Oat (Avena sativa) forage cultivars (Assiniboia, Bell and Baler). In the Dairy production trial eight multiparous Holstein cows at 9020 DIM averaging 41 kg/d milk yield were used in a 2 by 3 (28-day period) Switch back (Lucas) experimental design to compare dry matter intake (DMI), change in body weight, milk yield and milk composition of cows fed either 48 percent Assinoboia or Rosser (Barley- Hordeum vulgare) silages on dry matter basis as total mixed rations (TMR). Concentrate consisted mainly of rolled barley, canola meal and soy meal. In the total tract digestibility trial twenty-four sheep (n=6) in complete randomized design (CRD), were used to assess apparent digestibility of dry matter (DM), organic matter (OM), crude protein (CP), crude fat (EE), acid detergent fiber (ADF) and neutral detergent fiber (NDF) in Assiniboia silage, Bell hay, Baler hay and Rosser silage.
A significant increase (p<0.05) in milk fat percentage was observed with the Assiniboia based diet and actual milk yields were similar. Milk fat yield recorded with the Assiniboia diet was not statistically different. Milk protein and lactose percentages, and protein yield were higher (p<0.05) in cows fed Rosser based diet. Fat corrected milk (3.5 percent) yield was not different. Milk fatty acids (FA) when the Assiniboia based diet was fed, showed a remarkable increase (p<0.05) in Oleate ($C_{18:1}$) percentage and yield while the others were not different. The increase in Oleate resulted in an increase (p<0.05) in unsaturated FA to saturated FA ratio. Apparent digestibility coefficients (ADC) of DM, OM, NDF and EE of Assiniboia and Rosser were not different (p>0.05). Baler and Rosser ADCs of NDF and ADF were similar. It was apparent that Bell forage was chemically inferior to the other three. Assiniboia seemed equal to Rosser in apparent digestibility with sheep and resulted in higher milk fat percentage. It was concluded that Assiniboia could substitute for Rosser silage in dairy rations.

Key Words: Assiniboia, Rosser, Forage

315 Effect of various alternative forages on late summer forage production and grazing livestock performance.

W. Poland* and P.M. Carr, *North Dakota State University, Dickinson.*

The potential of using millet (M; *Setaria italica*), sweetclover (C; *Melilotus alba*) and alfalfa (A; *Medicago sativa*) as grazable forage in late summer was evaluated in southwestern ND. Forage treatments (TRT) were seeded into paddocks (1-ha) in each of two year and included M, C, A, barley (B; *Hordeum vulgare*), pea (P; *Pisum arvense*) and combinations of MC and MA. Paddocks were grazed starting in early August using yearling heifers (BW=432±4.6 kg). At initiation of grazing, seeded (P<.01; x=4170kg/ha; SE=720) and total forage (P<.01; x=5845kg/ha; SE=622) DM and percentage seeded of total forage (P<.01; x=68.0%; SE=5.9) differed by treatment. P produced more seeded DM than A and C (3670 vs 2056 and 2308kg/ha). MC and MA produced more seeded (6219 and 5757 vs 2056 and 2308kg/ha) and total (7598 and 7149 vs 4459 and 4523kg/ha) DM than A and C. Percentage seeded forage was greater in P (66%) compared to A (47%) and C (48%); in M (74%) compared to A, C, MA (81%) and MC (79%); and in MA and MC compared to A and C. Forage concentrations of

CP (P<.05; x=11.9%; SE=1.3), NDF (P<.01; x=57.5%; SE=2.0) and ADF (P<.01; x=38.9%; SE=1.1) differed by TRT. CP was greater in B (12.3%) compared to M (9.4%); in A (13.3%), C (16.1%), MA (11.5%) and MC (10.9%) compared to M; and in A and C compared to MA and MC. NDF was reduced in A (51.5%), C (47.0%), MA (60.9%) and MC (63.0%) compared to M (63.7%); and in A and C compared to MA and MC. ADF was reduced in B (35.8%) compared to M (41.3%); in A (37.3%), C (35.5%), MA (39.1%) and MC (39.5%) compared to M; and in A and C compared to MA and MC. Grazing days (P<.05; x=35.0d; SE=2.9), final BW (P<.1; x=465kg; SE=5.1) , ADG (P<.1; x=.91kg/d; SE=.14) and gain (P<.1; x=95.0kg/ha; SE=15.1) differed by TRT. Grazing days were greater in M (41 d) compared to B (33 d); in M compared to A (28 d), C (31 d), MA (37 d) and MC (35 d); and in MA and MC compared to A and C. A and C had heavier final weights (464 and 466 vs 453 kg) and larger ADG (1.04 and 1.00 vs .64 kg/d) and total gain (90.9 and 94.6 vs 59.3 kg/ha) compared to P. Annual grasses produced more forage of a lower quality compared to legumes. However with the exception of P, animal performance was not affected by forage treatment. Although forages differ with respect to production and quality, these characteristics alone are not accurate predictors of grazing animal performance.

Key Words: Forage, Grazing

316 Performance of crossbred steers grazing photoperiod sensitive and non photoperiod sensitive Sorghum Sudangrass hybrids.

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Twelve 2.23 ha pastures were seeded with 28 kg/ha of two non photoperiod sensitive (PP) sorghum sudan (SS) hybrids, SS 200 BMR or SS 201 BMR, or two PP SS hybrids, Mega Green (MG) or PS 210 BMR (n=3 pastures/hybrid). SS 200 BMR, SS 201 BMR and PS 210 BMR contained the brown midrib gene. Pastures were irrigated with 49.4 cm/ha and fertilized with 336 kg/ha of 20-10-0 before planting. Crossbred steers (n=132; avg BW=251 kg) were allotted to the pastures using a put-and-take pasture management. On d 0 and the last day of the grazing period, forage availability was determined by hand clipping six predetermined areas in each pasture. For the forage samples collected on d 0, leaf and stem percentages were determined. Grazing was terminated when forage growth and availability did not support steer growth. Amount of available forage at the initiation of grazing was greater (P=0.0464) for SS 201 BMR (3,002 kg/ha) than MG (2,163 kg/ha) or SS 200 BMR (2,206 kg/ha), with PS 210 BMR being intermediate (2,500 kg/ha). No differences (P=0.3869) occurred in the initial percentage of leaf or stem. Grazing head days/ha were greater (P=0.0234) for MG than for PS 210 BMR, SS 201, BMR and SS 200 BMR (447 vs 382, 373, and 373 d/ha). Amount of available forage at the conclusion of grazing was similar (P=0.2414) for the hybrids (1,763, 1,253, 1,186, and 868 kg/ha for MG, PS 210 BMR, SS 201 BMR and SS 200 BMR, respectively). Steers grazing SS 200 BMR had a greater (P=0.0086) ADG than those grazing MG, PS 210 BMR or SS 201 BMR (1.38 vs. 1.02, 1.05, and 1.16 kg/d, respectively). Gain per ha was greater (P=0.1010) for steers grazing SS 200 BMR (515 kg/ha) than PS 210 BMR (404 kg/ha) with MG (456 kg/ha) and SS 201 BMR (436 kg/ha) being intermediate. These data show that grazing SS 200 BMR resulted in greater ADG and gain/ha than PS 210 BMR.

Key Words: Grazing, Sorghum Sudangrass, Photoperiod Sensitive

317 Ruminally protected fructose improves carbohydrate status in early postpartum dairy cows.

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The post-parturient dairy cow suffers from carbohydrate insufficiency which is primary to excessive fat mobilization from body stores and the subsequent onset of fatty liver and lactation ketosis. Six multiparous Holstein and four multiparous Brown Swiss dairy cows were used to test the effects of ruminally protected fructose as a preventation for ketosis. Cows were paired by breed and calving date and were randomly assigned to one of two treatments: 1) control, 0.8 kg of a ruminally available starch source (ground corn) blended in 0.5 kg of a liquid fat/molasses based supplement topdressed on the daily ration or 2) fructose, 1 kg/d of ruminally protected fructose (80% fructose) in the liquid fat/molasses based supplement. Treatments were initiated on the day of calving and continued for 7 d postpartum. Feed intake and milk production were monitored, and milk composition was determined at 5, 6, and 7 DIM. Blood samples were collected at 5, 6, and 7 DIM for determinations of glucose, NEFA, and BHBA. Dry matter intakes were numerically greater for cows fed fructose (18.1 vs. 14.0 kg/d for fructose vs control, respectively, P > 0.05). Milk production was not affected by treatment and averages 32.2 and 33.2 kg/d for fructose and control cows, respectively. Milk composition was not changed except MUN concentrations increased for cows fed fructose (14.6 vs. 11.6 mg/dl, P < 0.05). Likewise, daily production of MUN was increased by fructose (5.89 vs. 4.04 g/d, P < 0.05). Milk protein production was also increased by fructose (1.48 vs. 1.22 kg/d, P < 0.05) Concentrations of glucose in blood tended to be increased by fructose (70.7 vs. 58.6 mg/dl, P = 0.10). Concentrations of BHBA were not affected by diet (6.20 vs. 4.74 mg/dl for fructose and control, P > 0.10); however, ruminally protected fructose did decrease concentrations of NEFA in plasma (414 vs. 573 μEq/L, P < 0.05). In summary, replacing starch with ruminally protected fructose improved the carbohydrate status of the early lactation dairy cow and may serve as a prevention for lactation ketosis.

Key Words: Fructose, Dairy Cows, Ketosis

318 Comparison of beef NRC model and equations using dilution rate to predict microbial efficiency and yield in the rumen.

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The NRC model predicts microbial efficiency (MOEFF) based on the maintence rate of the bacteria, the digestion rate of a feedstuff, and the theoretical maximum yield of the bacteria. Data from our laboratory have shown that dilution rate (DR) is determinant of microbial yield, growth and efficiency. The objective of this study was to compare equations based on DR and the NRC model to predict MOEFF. A single-flow continuous culture system operating at fractional DR of 0.03 and 0.06 per hour was used to determine MOEFF and bacterial N yield. Treatments consisted of diets containing two different levels of neutral detergent fiber (40 and 22 %). Diets were 1) 22 % ground corn (GC), 70 % soybean hulls (SH), and 8 % soybean meal (SBM; HF) and 2) 65 % GC, 25 % SH, and 10 % SBM (LF). Data from this study was used to assess the effectiveness of the two methods to predict MOEFF. The equations for calculating the passage rate were removed from the NRC model to allow for the programmed DR to be used in predicting MOEFF. The DR equations calculated MOEFF and bacterial N yield closer to the experimentally determined values than the NRC model for both diets at the low DR but not at the high DR. The experimentally determined MOEFF at the high dilution rate was lower than MOEFF reported in the literature for diets with similar DR. Data from published studies reporting organic matter intake, particulate flow rate and MOEFF were also used to compare MOEFF prediction equations. The DR-based equations tended to predict MOEFF, bacterial N yield and amino acid (AA) flow closer to the reported values than the NRC model. When the DR equations did not predict MOEFF similar to reported data there appeared to be a biological inconsistency between the measured DR and the MOEFF. Based on these findings DR-based equations to predict MOEFF, bacterial N yield and AA flow appear to be more accurate than the NRC model. Further investigations into the accuracy of using these equations to predict MOEFF and bacterial N yield is needed.

Key Words: Microbial Efficiency, Rumen Modeling

319 Effect of an estrogenic implant on performance of newly received steer calves or calves castrated on arrival.

H. A. DePra*, D. L. Step, R. E. Peterson, D. R. Gill, and C. R. Krehbiel, *Oklahoma State University*.

The objective of this experiment was to determine the effect of an estrogenic implant (10 mg of estradiol benzoate) on daily gain and feed efficiency of newly-received steers vs bull calves castrated upon arrival during a 42-d receiving study. A total of 104 steers (avg initial BW = 238 24 kg) and 103 bulls (avg initial BW = 239 23 kg) were received in two loads (one wk apart) at the Willard Sparks Beef Research Center during September 2002. At processing (d 0), bull calves were castrated using a Newberry knife and a single crimp emasculator. Calves were sorted by sex and blocked by initial BW, then randomly assigned to implant or no implant. All calves were fed a diet consisting of whole shelled corn, 49.7%; cottonseed hulls, 12%; ground alfalfa, 25%; molasses, 3%;

and pelleted supplement 10.3% (DM basis). The diet was formulated for 250 kg calves to gain 1.10 kg/d. Data were analyzed using the MIXED procedure of SAS. There was no sex X implant interaction (P = 0.63) for overall ADG. Daily gain was greater (P < 0.001) for steers (0.94 kg) compared with bulls (0.76 kg), and was greater (P < 0.001) for implanted (0.91 kg) vs non-implanted (0.79 kg) calves. Dry matter intake was not influenced (P =0.68) by sex over the 42-d feeding period (5.72 vs 5.63 kg/d for steers vs bulls, respectively). Across the 42-d feeding period, steers had 26% greater (P = 0.02) ADG:DMI than bulls. We conclude that an estrogenic implant administered to steer or castrated calves upon arrival at the feedlot will increase daily gain compared with non-implanted calves, and that the magnitude of the response to implant is similar in both steers and castrated calves. Despite the increased performance of castrated calves receiving an implant, both implanted and non-implanted steer calves had greater ADG and ADG:DMI than calves castrated at arrival over a 42-d receiving period.

Key Words: Castration, Implants, Receiving Cattle

320 Effect of copper level and zinc level and source on finishing cattle performance and carcass traits. L.J. McBeth*, C.R. Krehbiel, D.R. Gill, C.E. Markham, R.E. Peterson, R.L. Ball, C.K. Swenson, and S.S. Swanek, *Oklahoma State University*.

One hundred sixty heifers (BW = 317 22 kg; Trial 1) and 160 steers (BW = 341 18 kg; Trial 2) were fed for an average of 140 d to determine to effect of Cu level and Zn level and source on feedlot performance and carcass merit. Treatments were: 1) 80 ppm $ZnSO_4$ and 12 ppm amino acid complexed Cu (AACu); 2) 80 ppm $ZnSO_4$, 12 ppm AACu and 12 ppm $CuSO_4$; 3) 40 ppm $ZnSO_4$, 40 ppm amino acid complexed Zn (AAZn) and 12 ppm AACu; 4) 40 ppm $ZnSO_4$, 40 ppm AAZn, 12 ppm AACu and 12 ppm $CuSO_4$; 5) 320 ppm $ZnSO_4$ and 12 ppm AACu; 6) 320 ppm $ZnSO_4$, 12 ppm AACu and 12 ppm $CuSO_4$; 7) 160 ppm $ZnSO_4$, 160 ppm AAZn and 12 ppm AACu; 8) 160 ppm $ZnSO_4$, 160 ppm AAZn, 12 ppm AACu and 12 ppm $CuSO_4$. Heifers and steers were blocked by initial weight and assigned to 32 pens each (5 head/pen; 16 pens/block). Data were analyzed using PROC MIXED of SAS with treatment, pen and block as class variables and 28-d periods as repeated measures. The model included Cu level, Zn level, and Zn source and subsequent interactions. In Trial 1, no significant differences (P>0.10) were observed for overall gain, DMI, or feed efficiency. From d 0 to 27, DMI tended (P=0.11) to be greater for heifers consuming 320 vs 80 ppm Zn. No differences (P>0.01) were observed for hot carcass weight, ribeye area, kidney, pelvic and heart fat, marbling, quality grade, or yield grade. Twelfth-rib fat depth tended (P<0.10) to be greater for heifers fed 24 vs 12 ppm Cu and 320 vs 80 ppm Zn. In Trial 2, no significant differences (P<0.10) were observed for overall gain, DMI, or feed efficiency. At 12 ppm Cu, daily gain was significantly greater (P<0.01) for steers consuming AAZn vs $ZnSO_4$ from d 0 to 27. Dressing percent tended (P=0.09) to be greater for steers fed 320 vs 80 ppm Zn and was significantly greater (P>0.05) for steers consuming 12 vs 24 ppm Cu. Twelfth-rib fat depth tended (P=0.09) to be greater at 320 vs 80 ppm Zn, and was significantly greater (P<0.05) for steers consuming AAZn at 320 ppm Zn vs those consuming AAZn at 80 ppm Zn. In our experiments, there appeared to be no advantage to feeding 24 vs 12 ppm Cu and inconsistent with other research, source of Zn had little influence on animal performance or carcass merit.

Key Words: Copper, Zinc, Steers

321 Effect of cottonseed byproduct feeds on feedlot performance and carcass traits of finishing heifers. C.E. Markham*, C.R. Krehbiel, D.R. Gill, R.E. Peterson, and H.A. DePra, *Oklahoma State University*.

One hundred fifty crossbred yearling heifers (initial BW = 318 ± 12 kg) were fed to compare the effect of source and level of cottonseed byproducts on feedlot performance and carcass characteristics. A control treatment was established consisting of 78.5% dry-rolled corn, 7.5% cottonseed hulls (CSH), 3.0% fat and 8.7% cottonseed meal (CSM). Delinted whole cottonseed (DWC) or pelleted delinted whole cottonseed (PDWC) was included in the diet to replace CSH and supplemental fat (15% of diet DM), or to replace CSH, fat, and cottonseed meal (25% of diet DM). In the initial 28-d period heifers fed the control diet tended (P = 0.06) to have greater ADG compared with heifers fed 25% PDWC, 15% DWC or 25% DWC diets. From d 56 to 84, heifers fed 15% PDWC had the greatest (P < 0.001) ADG, while heifers fed the control, 15 or 25% DWC diets had the lowest ADG; 25% PDWC was intermediate. From d 112 to 140, heifers fed 15 or 25% PDWC or the 25% DWC diet had greater ADG (P = 0.03) than heifers fed 15% DWC with control cattle being intermediate. Over the entire feeding period (d 0 to 150), heifers fed the 15% PDWC diet had greater (P = 0.002) ADG and heavier (P = 0.001) final live weights (560 vs 540 kg) compared with heifers fed the DWC or control diets. Heifers fed 25% PDWC also tended (P = 0.10) to have greater ADG and final live weights than DWC and control treatments. No treatment differences (P > 0.10) were observed for overall DMI or feed efficiency. Heifers fed 15 and 25% PDWC had greater (P = 0.001) HCW (avg = 349 vs 337 kg, respectively) compared with heifers fed DWC and control diets. No other differences (P > 0.10) were observed for carcass traits. We conclude that including PDWC in finishing rations resulted in greater live weight gain and heavier hot carcass weights compared with DWC or a combination of corn, CSH, CSM and fat.

Key Words: Feedlot Cattle, Cottonseed, Byproduct Feeds

322 Effect of continuous infusion of degradable or undegradable intake protein on forage intake, digestibility and nitrogen balance in steers consuming low quality forage. R. Basurto-Gutierrez*, H. T. Purvis II, G. W. Horn, C. R. Krehbiel, J. S. Weyers, and T. N. Bodine, *Oklahoma State University, Stillwater, OK, USA*.

To determine the effect of undegradable intake protein (UIP) or degradable intake protein (DIP) on forage intake, digestibility and N balance in steers consuming low quality forage, eight cannulated Angus steers (598 68 kg) were assigned to a replicated 4x4 Latin square and fed ad libitum low quality prairie hay (PH; CP = 5.0). Supplemental N sources were casein and urea, which were considered as UIP or DIP sources depending on infusion site. The four supplemental treatments were: 1) control (CON; ad libitum PH); 2) undegradable intake protein (UIP; PH + 24-h abomasal infusion of casein, 55 g N/d); 3) degradable intake protein from casein (DIP; PH + 24-h ruminal infusion of casein, 55 g N/d); and 4) degradable intake protein from urea (UDIP; PH + 24-h ruminal infusion of urea, 55 g N/d). Each experimental period consisted of 10 d for adaptation and 6 d for sample collection. Total PH intake, output of feces and urine was collected daily. Nitrogen supplements were placed in water (3.6 L) and pumped at a rate of approximately 2.5 mL min-1 by a peristaltic pump. Nitrogen supplementation increased (P<0.01) forage intake compared with CON, but no difference was detected among supplemental nitrogen treatments (7.1 vs 9.1, 10.3 and 10.4 kg/d for CON, UIP, DIP and UDIP, respectively). Organic matter digestibility (52.0%) was not influenced (P>0.25) by treatment. Fecal (42.2, 56.3, 66.6, 64.2 g/d for CON, UIP, DIP and UDIP, respectively), absorbed (14.7, 69.7, 69.7, 75.8 g/d for CON, UIP, DIP and UDIP, respectively) and urine N (19.4, 44.3, 36.3, 51.8 g/d for CON, UIP, DIP and UDIP, respectively) reflected (P<0.01) total N intake. Excretion routes of N differed among treatments; urinary N was higher (P<0.02) with UDIP than with DIP. In contrast, fecal N was lower (P<0.01) with UIP than with DIP. Nitrogen supplementation increased (P<0.01) N balance to a similar plane independent of source or infusion site (-4.7 vs 25.4, 33.3, 24.0 g/d for CON, UIP, DIP and UDIP, respectively). These data show that N supplementation for cattle consuming low quality forage can increase forage intake independent of N source or location of infusion, and alter N excretion, while maintaining similar N balance.

Key Words: Low Quality Forage, Nitrogen Balance, Beef Cattle

323 Antibiotics in ruminant feeding practices. D. Hausmann* and D. Hausmann, *Alpharma Animal Health*.

Since the early 1950's, antibiotics have been administered through feed as a tool to promote growth and manage diseases affecting cattle: the end result being a safer food supply. The practice of utilizing antibiotics in this manner is currently being evaluated, as it has in the past, with respect to overall contribution to agriculture and relationship to public health issues.

The extent of antibiotic use in animals, relevance to human medicine, as well as feed-grade antibiotic applications in typical management schemes will be presented. The industry's struggle with proper and timely identification of those cattle requiring antibiotic intervention, and its cost to the industry will be discussed. Consumer perceptions surrounding

antibiotic use, and popular myths regarding the consequences of antibiotics in feed will also be examined.

Key Words: Feed, Antibiotics, Cattle

324 Targets for feed antimicrobials. M. Apley*, *Iowa State University*.

Feed additive therapeutic or disease control approvals for cattle include amprolium (coccidiosis), bacitracin (liver abscesses), chlortetracycline (liver abscesses, E. coli enteritis, pneumonia, anaplasmosis), decoquinate (coccidiosis), monensin (coccidiosis), neomycin (colibacillosis), oxytetracycline ((liver abscesses, E. coli enteritis, bacterial enteritis, pneumonia), and tylosin (liver abscesses). There is a different set of approvals for swine, poultry, and some minor species.
Feed application of these additives results in different pharmacokinetic profiles than if they were to be administered in a bolus dose, either orally or parenterally. The science of relating these pharmacokinetic parameters to the amount needed to inhibit or kill the target pathogen is referred to as pharmacodynamics. Recently, pharmacodynamic relationships have also been evaluated for predicting the potential for a given dosing regimen to contribute to antimicrobial resistance.
These feed additives, regardless of target species, share some regulatory aspects. Extralabel use of feed antimicrobials is banned in the United States. It is important to note that milk replacer is not considered a feed in regards to this regulatory ban.
Guidance document 152, recently released by the FDA Center for Veterinary Medicine, is designed to evaluate the potential impact of food animal antimicrobial use on human health. In this document, multiple aspects of antimicrobial use are subjectively classified as being of low, medium, or high risk to human health. The release assessment portion of this draft guidance for industry includes a section on resistance selection pressure. In this section the extent of use is considered in the areas of individual vs. small groups vs. flocks or herds. An antimicrobial applied to an entire flock or herd will most likely receive higher scrutiny for potential resistance development.

Key Words: Antimicrobials, Feed, Indications

325 Appropriate usage of antibiotics for disease control. A. Confer*, *Oklahoma State University*.

Bovine respiratory disease, especially bacterial pneumonias in beef and dairy cattle, will be used as the model disease for this discussion. The main bacteria that cause pneumonia in cattle, Mannheimia haemolytica, Pasteurella multocida, Haemophilus somnus, Arcanobacterium pyogenes and Mycoplasma bovis, and the different lesions produced will be reviewed. There will be a discussion of typical antibiotic treatment strategies and how they may contribute to an apparent increase in prevalence of chronic pneumonia and possible reasons why this has occurred. Shifts in antibiotic resistance for the various respiratory bacterial pathogens will be described. The need for better and/or more critical diagnostic techniques for cattle that need to be treated with antibiotics will be discussed along with the value of current and the need for better respiratory vaccines.

Key Words: Bovine Respiratory Disease, Antibiotic Resistance, Vaccines

326 Modeling alternative strategies to stabilize host response in subclinical disease. T.H. Elsasser*, *USDA, ARS Growth Biology Laboratory*.

Subclinical infection and disease load presents a significant challenge to producers and veterinarians. Often overlooked or undiagnosed, the presence of the vectors that define the subclinical situation are a real concern due to the potantial for disease transmission via several "shedding" routes as well as priming animals for more severe reaction to a secondary infection. Traditional uses of the lower levels of antibiotics for disease control purposes has come under tremendous scrutiny and criticism. Issues regarding the development and transmission of antibiotic resistance in microbes of food animals are at the forefront of risk assessment paradigms. In this regard, alternatives to antibiotic regimens can be developed, but more importantly they need to be used where available. Certain commonsense approaches can be partnered to capitalize on these alternatives. At the heart of alternative approaches to disease management are the "3 needs": the alternative actually needs to be effective, it needs to readily implementable into an existing management program, and it needs to be economical. In this light therefore one should rethink what constitutes "disease", which is actually the biochemical manifestations of the host response to the presence of an immunological threat. An important consideration in the development of "alternatives" might be to focus on what can be done to stabilize host homeostatic mechanisms and allow the animal to utilize its own defenses to combat the vector. Approaches are being developed that renge from nutrient alterations to genetic manipulation of endogenous antimicrobial peptides. Finally, where we can anticipate the timing of certain production stresses, including birth/parturition, weaning, transport, feeding changes, etc., we may be able to provide dietary supplements in the short term to limit stress-related free radical production and imbalances in the intracellular REDOX potential that set animals up for metabolic imbalances. When animals are less than stabile they are more susceptible to opportunistic infections.

Key Words: Antibiotics, Redox Potential, Infection

327 Comparison of two heifers development systems on a commercial ranch. T. W. Loy*[1], D. C. Adams[1], T. J. Klopfenstein[1], J. A. Musgrave[1], and B. Teichert[2], [1]*University of Nebraska, Lincoln,* [2]*Rex Ranch, Ashby, Nebraska*.

Spring-calving heifers were used in a two-year study to evaluate two systems of developing bred heifers. The control system (CON; n = 558) included native winter range, undegradable intake protein supplement (average 0.5 kg / d), and increasing amounts of hay (average 3.3 kg / d). The alternative system (TRT; n = 559) included winter range and increasing amounts of a dry corn gluten feed-based supplement (average 1.5 kg / d). Supplements were formulated to meet protein requirements, and systems were designed to supply similar NE. Heifers were managed as a group throughout calving and the subsequent grazing season. Weights and body condition scores (BCS) were assigned during the fall as yearlings (Sept to Oct), near the beginning of the calving season (March 1), and in the fall as two-year-olds. Calf birth and weaning weights were recorded. Pregnancy as two-year-olds was determined by rectal palpation. Weight and BCS data were analyzed using the GLM procedure of SAS, and pregnancy data by chi-square analysis. Initial weight was 393.3 kg, BCS was 5.5, and neither differed ($P > 0.42$) by treatment. A year x treatment interaction was detected for weight and BCS change prior to calving. In year 1, no difference was observed ($P = 0.69$) in weight change, although TRT heifers lost less ($P = 0.02$) BCS than CON. In year 2, TRT heifers gained more ($P < 0.01$) weight and lost less ($P < 0.01$) BCS than CON. Calf birth and weaning weight were not affected ($P > 0.21$) by treatment, although calves nursing TRT cows tended ($P = 0.10$) to have higher ADG than those nursing CON cows. Post-calving weight loss was 22.2 kg, which was not affected ($P = 0.88$) by treatment. A year x treatment interaction in BCS change was observed, with a similar ($P = 0.38$) increase in BCS occurring in year 1, while TRT cows lost more ($P = 0.04$) condition than CON in year 2. Pregnancy rate was 96.1% and was not affected ($P = 0.87$) by treatment. Bred heifers can be managed on winter range and supplement without compromising performance.

Key Words: Heifer Development, Supplementation

328 Effects of fat supplementation on heat-stressed lactating beef cows grazing endophyte-infested fescue. E Myers*, E Vanzant, L Anderson, R Burris, B Hightshoe, J Johns, and K Schillo, *University of Kentucky*.

To assess the effect of a high-fat liquid supplement on heat-stressed lactating beef cows grazing endophyte-infested tall fescue (E+), 130 predominantly Angus cows (initial BW = 563 kg; initial body condition score (BCS) = 5.7; 1 to 9 scale) at 2 locations (n=80 at location ARC, n=50 at location PTN) were allotted to 8 (ARC) and 4 (PTN) E+ pastures, balanced within location for calf birth date, calf sex, cow age, cow BCS, and cow BW. Within location, half of the groups were randomly assigned to receive either a commercial liquid supplement containing approximately 22% fat (MIX-30^{TM}, AgriDyne, Inc; MIX) or a corn/soybean meal supplement (CON) fed to provide similar amounts of ME and CP from 30 days before, through the last day of a 60-d breeding season. Cows were offered MIX twice weekly on a free choice basis up to 2.72 kghd-1d-1; CON groups were fed supplement daily with intakes adjusted twice weekly to match MIX intakes. No treatment x location interactions were detected (P > 0.10). Cows receiving MIX gained more

weight (P = 0.08; 14.1 vs. 5.2 ± 3.5 kg), and body condition (P < 0.01; BCS change = 0.24 vs -0.17 ± 0.08 BCS units), had higher pregnancy rates (P = 0.05; 74 vs 57 ± 6%; determined by ultrasound 35 d after end of breeding season), lower final body temperatures (P < 0.01; 38.8 vs 39.3 ± 0.06 °C), greater body temperature decrease (P < 0.01; -0.26 vs 0.07 ± 0.06 °C), and lower serum thyroxine concentrations (P < 0.01; 35 vs. 40 ± 1.0 ng/mL; ARC only) than cows receiving CON. Final calf weights and calf average daily gains were unaffected (P > 0.10) by treatment. Supplementing heat-stressed cows from 30 d before, through the end of the breeding season with a liquid, fat-containing supplement increased pregnancy rates by 17%, decreased body temperatures by 0.5 °C, and lowered serum thyroxine concentrations compared with corn/soybean meal supplementation.

Key Words: Dietary Fat Supplement, Pregnancy, Beef Cow

329 Effect of increasing level of soybean hulls on intake and utilization of endophyte-infested tall fescue hay by beef steers. L. van Rensburg*, E.S. Vanzant, J.A. Benson, C.L. Adkins, and K.A. Beighle, *University of Kentucky, Lexington.*

Twenty ruminally cannulated, crossbred beef steers (476 kg) were randomly assigned within weight blocks to receive soybean hulls (SH; 18.0% CP; 58.7% NDF) at 0, 0.32, 0.64, 0.96, or 1.28% (DM basis) of BW as a supplement to endophyte-infested tall fescue hay (14.1% CP; 68.0% NDF). Adaptation (d 1 to d 14) was followed by total fecal collection (d 15 to d 21), Co:EDTA dosing (d 22 at 0600) and subsequent ruminal fluid sampling (d 22; 0600, 1100, 1400, 1700, 2000; d 23 at 0600) for Co, pH, NH3-N, and VFA analyses. Voluntary forage DMI decreased linearly (P < 0.01; 1.61, 1.55, 1.41, 1.19, and 1.05 %BW) and total (1.61, 1.87, 2.05, 2.15, and 2.33 %BW) and digestible (0.96, 1.16, 1.32, 1.43, and 1.52 %BW) DMI and liquid dilution rate (9.4, 10.0, 10.6, 11.7, and 12.2 %/h) increased linearly (P < 0.02) with increasing SH. Total tract DM digestibility increased as SH increased from 0 to 0.96% BW and plateaued with the next increment of SH (quadratic; P = 0.01; 59.6, 61.9, 64.6, 66.8, and 65.6%). All ruminal fermentation characteristics except molar proportion of acetate had sampling time x treatment interactions (P < 0.10). Generally, ruminal pH decreased linearly (P = 0.07) and total VFA concentrations increased linearly (P < 0.02) with increasing SH. Peak ruminal NH3-N concentrations (at 1100) increased as SH increased from 0 to 0.96% BW and decreased with the next increment of SH (quadratic; P < 0.01). Molar proportions of acetate decreased (linear; P < 0.01) with increasing SH and, in general, molar proportions of propionate increased (P = 0.06) with increasing SH. For C4 and C5 VFA, observed differences were characterized by increasing proportions with increasing SH. Changes in digestible DMI and modest shifts in fermentation characteristics suggest that increasing SH supplementation from 0 to 1.28% of BW would result in linear increases in growth of stocker cattle consuming endophyte-infested fescue.

Key Words: Forage Utilization, Fiber Supplements, Beef Steers

330 Restricting time of access to large round bales of hay on cow performance, hay waste, manure production, and manure nutrients. T. C. Cunningham*, D. B. Faulkner, A. J. Miller, and J. M. Dahlquist, *University of Illinois at Urbana-Champaign.*

Restricting time of access to round bales of hay on cow performance, hay waste, manure production and manure nutrients was evaluated in two experiments. In Exp. 1, seventy-two Simmental cows (616.7 28.3 kg) with calves were used in four replications to evaluate three treatments: Ad libitum hay (no time restriction) or access restricted to 8 or 4 hours/day. All treatments received high quality hay (relative feed value=134) stored inside. Cows and calves were randomly allotted to 12 pens 24 h after parturition. Final cow weight (P=.06) and BCS (P=.04) increased as hay access times lengthened. Calf weight and milk production were not affected by access time. Hay disappearance for 4h cows was 37% less than for cows having ad libitum access to hay (linear, P=.01). Manure production (kg DM/hd/d) was increased (P=.02) with increasing time of access to hay. Manure output of N, P, and K (kg/hd/d) increased (P=.01) with increased time allowed to hay. Nitrogen disappearance (kg/hd/d) increased linearly (P=.01) with increasing time of access to hay, however, % N recovered was not different across treatments. In Exp. 2, 72 Simmental cows (593 18.6 kg) in the third trimester of gestation were evaluated in four treatments: ground hay (100%) fed to meet NRC recommendations (7.5 kg/hd/d); and access to hay restricted to 3, 5, or 7 hours/day. All treatments were fed average quality hay (relative feed value=80) stored outside. Cows were blocked by weight and assigned to 12 pens resulting in 3 replications. Cow weight (P=.08) and cow weight change (P=.04) improved with increasing time allowances. Manure production (kg DM/hd/d) tended to increase (P=.08) with longer access to hay. Increases in N disappearance (kg/hd/d) (P=.01) and %N recovered (P=.02) were observed with increasing time allowance to hay. Manure output of N, P, and K (kg/hd/d) increased (P<.05) for longer time periods. Restricting time of access to large round hay bales reduced hay disappearance while maintaining acceptable cow performance.

Key Words: Cows, Hay, Limit-feeding

331 Restricted feeding of ground hay on cow performance, manure production, and manure nutrients. T. C. Cunningham*, D. B. Faulkner, A. J. Miller, and J. M. Dahlquist, *University of Illinois at Urbana-Champaign.*

One hundred eight Simmental cows (614 30.0 kg) with calves were used to evaluate the effects of restricted-feeding ground hay on cow performance, manure production, and manure nutrients. Cows and calves were randomly allotted to 12 pens 24 h after parturition, resulting in 4 replications, with 9 head per pen. Average quality hay (relative feed value = 105) stored inside was used in three feeding levels: 100% NRC requirement for maintenance (14 kg DM/hd/d); restricted-fed hay at 90% of NRC (12.7 kg DM/hd/d); restricted-fed hay at 80% NRC (11.2 kg DM/hd/d). All hay was ground to pass a 7.6 cm screen. Trial duration was 75 days. Diets were fed once daily and supplemented with 200 mg of Rumensin along with .9 kg cracked corn and .11 kg mineral as a carrier. No differences in cow performance or calf gain were observed. Manure production (kg DM/hd/d) numerically increased with increased feeding level, but was not significant (P=.36). As designed, a linear treatment effect (P=.001) was observed for hay disappearance (kg DM/hd/d) with increased feeding levels. Cows on the 80 and 90% restricted-fed treatments actually received restricted levels of 84.1 and 91.3%, respectively. Percent DM recovery as a percent of DM disappearance was calculated for each pen from hay disappearance and manure production. A trend for increased %DM recovery as a percent of DM disappearance was observed with increased feeding level, however, no statistical differences were observed. Nitrogen disappearance (kg/hd/d) linearly increased (P=.01) with increased feeding level, however, %N recovered as a percent of N disappearance did not differ across treatments. Manure output of P (kg/hd/d) tended to increase (P=.09) as feeding level increased. Results from this study indicate restricted-feeding ground forages at levels slightly below NRC recommended maintenance levels may be a viable feeding strategy for producers to achieve a desired level of performance for their cows. Additional benefits may include reduced manure production and manure nutrient output.

Key Words: Hay, Restricted-feeding, Cows

332 Effects of program-fed corn/hay diets on performance, lactation and manure production. A.J. Miller*[1], D.B. Faulkner[1], and K.E. Tjardes[2], [1]*University of Illinois at Urbana-Champaign,* [2]*South Dakota State University, Brookings.*

Ninety-six developing heifers (195 ± 35 kg) were allotted to 3 treatments (4 pens/treatment): 90% Hay:10% Concentrate (HAY); 50% Hay:50% Concentrate (50:50); or 10% Hay:90% Concentrate (CORN); to determine the effects of program-fed intermediate levels of forage and concentrate on heifer performance and manure production. Concentrate consisted of 76% cracked corn and 24% SBM. HAY was fed ad libitum and other diets were restricted to be isocaloric. Heifer ADG increased linearly with increasing levels of concentrate (P<0.001; 0.52, 0.73, 0.83 kg). By design DMI decreased linearly with increasing concentrate level (P<0.001; 5.32, 4.63, 4.00 kg/hd/d), resulting in a linear increase in gain:feed for program-fed diets (P<0.001; 0.099, 0.159, 0.208). Manure production was weighed and sampled by cleaning pens at the beginning and end of a 28 day period. Manure production decreased curvilinearly with increasing concentrate levels (linear P<0.001, quadratic P<0.01; 0.98, 0.39, 0.20 kg/hd/d). Manure composition results indicate linear increases in percent nitrogen (N) and phosphorus (P) (=.015) and decrease in percent potassium (K) (P=.015) resulting in curvilinear decreases in total N, P, and K recovered in the manure (linear P=.0001, quadratic P=.06). Experiment 2 utilized 46 lactating Simmental cows

(560 ± 66 kg) blocked by calving date and assigned to 3 pens per treatment following calving for 88 ± 15d. Diets were identical to Exp. 1 with HAY being fed at 12.4 kg/hd/d. Cow ADG increased linearly with increasing concentrate levels (P<0.001; -0.32, 0.11, 0.45 kg), as did cow body condition score change (P<0.001; -0.07, 0.54, 1.15). Milk production tended toward a curvilinear response (linear P=0.07, quadratic P=0.08; 7.03, 8.69, 8.30 kg/d). Percent total solids and percent fat in milk were highest for 50:50 (quadratic P<0.02). Calf ADG was not different (P>0.2). Program-fed corn-based diets improved heifer and lactating cow performance while reducing manure production and total N, P, and K excretion.

Key Words: Cows, Program-fed, Corn

333 Mineral content of forages grown on poultry litter-amended soils. B. C. McGinley*[1], K. P. Coffey[1], J. B. Humphry[1], T. J. Sauer[2], H. L. Goodwin[1], W. K. Coblentz[1], and L. J. McBeth[1], [1]*University of Arkansas, Fayetteville, AR,* [2]*USDA National Soil Tilth Lab, Ames, IA.*

Large amounts of poultry litter are applied each year to pastures in northwest Arkansas and northeastern Oklahoma resulting in an increase of certain minerals in the soil. The objective of this study was to monitor the mineral concentrations in forages grown on poultry litter-amended soils and compare concentrations of these minerals with those required by beef cows during gestation and early lactation. Four farms in NW Arkansas and NE Oklahoma with a history of broiler-litter application were used to monitor forage mineral concentrations and the grass tetany ratio (equivalent ratio of K to Ca + Mg) from April 2000 to March 2002. Two-year mean forage Ca, P, K, S, Fe, and Zn concentrations from each farm were greater (P<0.05) than NRC requirements for gestation and lactation. Forage concentrations of Ca, P, K, and Zn rarely fell below requirements for lactating beef cows on any date during the study. Mean forage Mg concentrations from one farm were (P<0.05) above requirements for lactating beef cows while those from three farms were not different (P<0.05) from the requirements. However, forage Mg concentrations during January and February of 2001 and 2002 on each farm fell below the Mg requirement for beef cows in early lactation. Mean tetany ratios from all farms were below (P < 0.05) the tetany threshold of 2.2, but forage from one farm surpassed the tetany ratio of 2.2 during the spring of 2000 and another surpassed the tetany ratio during the spring of 2000 and 2001. Average forage Cu concentrations were above (P<0.05) requirements on one farm (12 mg/kg), below (P<0.05) requirements on another farm (8.5 mg/kg) and did not differ (P<0.05) from the requirements on two farms. Forage Cu concentrations were at or below beef cow requirements during much of the fall of 2000 and early winter of 2001 on each farm. Pastures fertilized with broiler litter may meet most but not all mineral requirements of beef cattle and warrant supplementation of specific minerals, particularly Mg.

Key Words: Manure Management, Forage, Minerals

334 Effect of harvest date and fertilization rate on nitrogen degradation of bermudagrass. B. C. McGinley*, K. P. Coffey, W. K. Coblentz, N. W. Galdamez-Cabrerra, and J. E. Turner, *University of Arkansas, Fayetteville, AR.*

Fertilizing bermudagrass (Cynodon dactylon) with N can produce large quantities of forage and increase plant N concentrations. Bermudagrass growing on a layer manure-amended site was fertilized with ammonium nitrate at four rates (0, 56, 112, and 168 kg N/ha) approximately one month before first and third harvests on May 30 and August 18, 2000 to determine in-situ degradation kinetics of N and neutral detergent insoluble N (NDIN). Five crossbred ruminally-cannulated steers (BW=422 21.0 kg) were used to evaluate in-situ degradation kinetics in a randomized complete block design with a 2 x 4 factorial arrangement. The immediately soluble N fraction (Fraction A) was greater (P<0.05) for bermudagrass harvested May 30, but the potentially degradable N fraction (Fraction B) was greater (P<0.05) for bermudagrass harvested August 18. Fraction A was greater (P<0.05) and fraction B was lower for forage fertilized with 112 and 168 kg N/ha compared with fertilization at lower N rates. A harvest date x N fertilization rate interaction (P<0.05) was detected for the undegradable N fraction (fraction C) and for effective ruminal N degradation. Effective ruminal N degradability was greater (P<0.05) within each harvest date for bermudagrass fertilized with 112 and 168 kg N/ha compared with lower N fertilization rates and was also greater from each of the forages harvested on May 30 compared with August 18. Fraction A of NDIN was not affected (P<0.05) by harvest dates or N fertilization rates. Fraction B was greater (P<0.05) on May 30 than August 18. A harvest date x fertilization interaction (P<0.05) was detected for fraction C. Rate of NDIN degradation was not affected (P<0.05) by harvest date or fertilization rate. Effective degradability of NDIN was improved (P<0.05) by N fertilization. Nitrogen fertilization may improve the degradability of both total N and NDIN from bermudagrass. Later harvests may have lower degradability of total N, but NDIN may not be affected.

Key Words: Cynodon Dactylon, Nitrogen, In Situ Degradation

335 Utilization of genetically enhanced corn residue for grazing. C. B. Wilson*[1], C. N. Macken[1], G. E. Erickson[1], T. J. Klopfenstein[1], and E. Stanisiewski[2], [1]*University of Nebraska, Lincoln, NE,* [2]*Monsanto Company, St. Louis, MO.*

Two studies were conducted to evaluate transgenic and non-transgenic corn for residue grazing. The objectives were to compare growth performance of steers grazing 1) corn residue from a Corn Root Worm protected (Bt) corn (event MON 863) and the near isogenic, non-transgenic (nonBt) corn, and 2) corn residue from a Roundup Ready® (RR) corn (event nk603) and the near isogenic, non-transgenic (nonRR) hybrid. In the first study (Exp 1), two irrigated corn fields were used after grain harvest of RR and nonRR control. The second study (Exp 2) was conducted the following year using dry land corn with Bt, RR, and their non-transgenic controls. In Exp 1, 64 crossbred steer calves (241 kg) were stratified by weight, and assigned randomly to one of eight equally sized pastures (4 RR and 4 nonRR). Each pasture was stocked with 8 steers to achieve stocking rates of .354 ha/steer/60 d. In Exp 2, 128 crossbred steer calves (262 kg) were used in a completely randomized design with four, 13.8 ha fields (Bt, nonBt, RR and nonRR corn residue). Steers were assigned as in Exp 1 to one of sixteen equally sized pastures (4 pastures per hybrid) for 60 d. Each pasture was stocked with 8 steers to achieve stocking rates of .43 ha/steer/60 d. Both experiments were supplemented with protein supplement (.45 kg/steer/d) to ensure protein intake did not limit performance. Steer performance data were analyzed using the GLM procedure of SAS. Exp 1 grazing was terminated at 35 d due to snow cover. There was no significant difference (P > .05) in steer performance. In Exp 2, steer performance was not different between Bt corn or RR corn and their respective controls following the 60 d grazing period. Steer ADG for the Bt and nonBt were .40 and .34 kg/d. Roundup Ready and nonRR were similar with ADG of .39 and .36 kg/d. The animal performance data demonstrates feeding value of corn residue does not differ between genetically enhanced corn hybrids and their near isogenic, non-transgenic controls.

Key Words: Corn Residue Grazing, Transgenic Corn, Beef Cattle

336 Supplement type and frequency on intake and performance, and energy value of dry distillers grains in a high-forage diet. T. W. Loy*, T. J. Klopfenstein, G. E. Erickson, and C. N. Macken, *University of Nebraska, Lincoln.*

Crossbred heifers (n = 120; 265 kg, SD = 37) were individually fed to determine the effect of supplement type and frequency on intake and performance, and to measure the energy value of dry distillers grains plus solubles (DDGS) in a high-forage diet. Treatments were arranged in a 3 x 2 x 2 factorial, with three supplements, two levels and two frequencies of supplementation. Supplements included dry rolled corn (DRC), DRC with corn gluten meal (DRC+CGM), and DDGS. Supplements were fed at 0.21% (LOW) or 0.81% (HIGH) of BW, and were provided daily (DAILY) or three times weekly (ALT) in equal portions, with 7-d supplement intake similar between DAILY and ALT. Heifers were fed to consume grass hay (8.7% CP) ad libitum. Weights were recorded every 28 d, with supplement levels adjusted accordingly. Individual DMI, diet composition, BW, and ADG were used to calculate energy values for DDGS and DRC. Supplement type, level, frequency, and interactions were tested using the GLM procedure of SAS, with initial weight included as a covariate. Supplement by level interactions for gain ($P = 0.01$) and efficiency ($P < 0.01$) were detected. At the LOW level, DDGS heifers gained more and were more efficient ($P < 0.03$) than DRC or DRC+CGM. No performance differences were observed ($P > 0.22$) between DDGS and DRC+CGM in HIGH treatments, although both improved ($P < 0.01$) gain and efficiency relative to DRC. Calculated NE content of DDGS was 27% higher than DRC. Gain and

efficiency were improved ($P < 0.01$) in heifers fed HIGH vs LOW. Total intake was higher ($P < 0.01$) for HIGH than LOW (2.35 vs 2.06% BW, respectively). However, LOW heifers consumed more hay ($P < 0.01$) than HIGH (1.78 vs 1.49% BW, respectively). Heifers supplemented DAILY consumed more ($P < 0.01$) hay and total DM than ALT heifers. Daily supplemented heifers gained more ($P < 0.01$) than ALT, but efficiency was not affected ($P = 0.85$) by supplementation frequency. In a high forage diet, DDGS has a higher energy value than corn.

Key Words: Dry Distillers Grains, Supplementation, Forage Intake

337 Estimation of rumen undegradable protein in forages using neutral detergent insoluble nitrogen at a single in situ incubation time point.

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Two experiments were conducted to evaluate the use of neutral detergent insoluble nitrogen (NDIN) at a single in situ incubation time point to estimate the rumen undegradable protein (UIP) in forages as well as to compare rates of NDIN degradation. In Experiment 1, forage samples from upland range and subirrigated meadow were incubated in situ for their mean retention time estimated from in vitro dry matter digestibility plus a 10 hour lag. Samples were also incubated for 0 h, 10 h, 75% of the estimated total mean retention time (TMRT), and 96 h. Rates of ruminal degradation were calculated using the slope of the regression of the natural logarithm of the potentially degradable NDIN remaining (96 h indigestible fraction subtracted) against time. Rates of degradation for forage samples from range and meadow sites collected in May and June were slower from 0 to 10 h than from 10 h to 75% TMRT ($P < 0.05$) but were not different for collections from July to September ($P > 0.1$). The estimated UIP using 75% of the TMRT was highly correlated ($R^2 = 0.95$) with UIP values obtained from the fractional rates of degradation and passage plus accounting for a 10 h passage lag. In Experiment 2, clip samples of four forages (alfalfa, birdsfoot trefoil, kura clover, and smooth bromegrass) and diet samples containing mixtures of alfalfa/brome, birdsfoot trefoil/brome, kura clover/brome, or brome were incubated in situ as described in Experiment 1. Estimated UIP values using 75% of the TMRT were highly correlated ($R^2 = 0.99$) with those obtained using fractional rates of degradation and passage plus accounting for a 10 h lag. Rates of degradation were not different from 0 to 10 h and 10 h to 75% TMRT ($P = 0.3253$ and $P = 0.8690$ for diet and clip samples, respectively). The UIP of the forages used in these two experiments was accurately estimated using a single in situ incubation time point equivalent to 75% of the TMRT, and rates of digestion can also be obtained at this time point plus 0 h and 96 h.

Key Words: Rumen Undegradable Protein, Neutral Detergent Insoluble Nitrogen, Forages

338 Effects of roughage source and particle size on feedlot performance and subsequent carcass characteristics of finishing heifers.

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One hundred crossbred yearling heifers (initial BW = 364 ± 10 kg) were fed to evaluate differences in feedlot performance and carcass characteristics due to roughage source and particle size. Diets consisted of 80% dry rolled corn (DM basis), 3% fat, a pelleted supplement, and one of four roughage treatments. Dietary treatments consisted of either 12% alfalfa hay (32% NDF; DM basis) or 4.5% cottonseed hulls (86% NDF; DM basis) as the roughage source, and diets were formulated to provide an equal concentration of NDF from roughage. Geometric mean diameter (d_{gw}) of the roughage treatments was determined by dry sieving, and particles retained on a 1.18-mm screen or greater were considered physically effective. Alfalfa hay was fed either coarsely chopped (AC; $d_{gw} = 4.73$ mm) by a Rotomix bale processor, or finely ground (AF) through a hammer mill equipped with a 1.3 cm screen ($d_{gw} = 1.13$ mm). Cottonseed hulls were fed as either unprocessed (CSH; $d_{gw} = 4.78$ mm) or pelleted (PCSH; $d_{gw} = 8.76$ mm). The percent of roughage retained in the physically effective fraction was 99.8, 96.0, 77.2 and 34.0% for PCSH, CSH, AC and AF, respectively. Physically effective NDF from roughage was estimated to be 10.9% for AF, 24.6% for AC, 82.6% for CSH and 85.9% for PCSH. Total dietary NDF concentrations were 19.8, 17.2, 18.0 and 19.6% (DM basis) for AC, AF, CSH and PCSH, respectively. No treatment differences were observed for ADG ($P = 0.78$) or DMI ($P = 0.44$). In the initial 28-d period, heifers fed AF had greater ($P < 0.05$) ADG:DMI compared with the other treatments. However no differences were observed for feed efficiency in the subsequent periods and overall efficiency did not differ ($P = 0.84$) among treatments. Additionally no treatment differences ($P > 0.10$) were observed for any carcass characteristics. We conclude that altering roughage source (alfalfa vs CSH) or physical form does not affect performance or carcass characteristics of heifers fed high-grain diets balanced for NDF from roughage.

Key Words: Feedlot Cattle, Roughage Source, Particle Size

339 Effect of limit-feeding on performance, carcass merit, and digestion by finishing steers.

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Angus steers (n = 84; BW = 348 ± 21 kg) were used to evaluate the effects of limit-feeding on performance, carcass merit, and digestion. Treatments consisted of 3 diets that were formulated to promote a 1.6 kg ADG at intake levels corresponding to approximately 100% **(AL)**, 90% **(90)**, or 80% **(80)** of ad libitum intake. Each diet delivered similar NE and MP at prescribed intake levels. Daily feed amounts offered to each treatment group were determined according to the previous 3-d average intake for steers on the **AL** treatment. Intake of offered feed by all treatment groups was usually complete each day. Actual DM intakes during the trial, as a percent of average BW, were 2.55% for **AL**, 2.38% for **90** (93% of **AL**), and 2.02% for **80** (79% of **AL**). Steers on the **80** treatment had greater ($P < 0.01$) ADG and G:F than **AL** or **90** steers (ADG = 1.61, 1.53, and 1.82 kg and G:F = .14, .15, and .19 kg gain/kg DMI, for **AL**, **90** and **80**, respectively). Hot carcass weights of **80** steers were greater ($P = 0.01$; 365 kg) than steers on the **AL** (350 kg) or **90** (343 kg) treatments. Marbling scores of **AL** and **80** steers were greater than those of **90** steers ($P < 0.05$); however, average quality grade for all three treatments was low Choice. Yield grade tended to be improved in **90** and **80** steers ($P = 0.11$; 3.20 and 3.26, respectively) compared to **AL** steers (3.56). Ribeye area was not affected by treatment ($P = 0.28$). A second trial (12 steers; BW = 440 ± 21 kg) was conducted to evaluate digestion characteristics of the diets used in the feedlot experiment. Fecal output by **80** steers was reduced ($P < 0.01$; 3.98 g DM/kg BW) relative to **AL** and **90** steers (6.16 and 6.01 g DM/kg BW, respectively). Digestion of OM by **80** steers was greater ($P < 0.01$; 80.2 %) than by **AL** and **90** steers (72.8 and 70.7%, respectively). Growth performance was greater than that predicted by NRC models when finishing steers were fed a diet formulated to promote 1.6 kg ADG but limited to approximately 80% of ad libitum DMI.

Key Words: Intake, Digestion, Steers

340 Comparative value of full-fat corn germ, whole cottonseed, and tallow as energy sources for lactating dairy cattle.

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Twenty four multiparous Holstein cows were used in six simultaneous 4 x 4 Latin squares with 28 d periods to evaluate full-fat corn germ as a fat source for lactating dairy cows. Experimental diets were: 1) control (C) 3.5% fat; 2) whole cottonseed (WCS) 5.1% fat; 3) tallow (T) 5.1% fat; 4) full-fat corn germ (FFCG) 5.1% fat on a dry matter basis. Cows were fed ad libitum twice daily at 0600 h and 1800 h. Inclusion of cottonseed meal and cottonseed hulls in the C, T, and FFCG diets balanced fiber and protein fractions with the WCS diet. Dry matter intake (DMI), milk yield, and energy corrected milk (ECM) did not differ ($P > 0.10$) among the diets. Milk fat from cows fed FFCG was lower ($P < 0.01$) compared to cows fed WCS but similar to cows fed C or T. Milk protein was lower ($P < 0.01$) for cows fed FFCG than those fed C but not different from cows fed WCS or T. Milk fat yield was greater ($P < .05$) for cows fed WCS than cows fed FFCG or T, but protein and lactose yield were similar among the diets. Efficiency (ECM/DMI) was greater ($P < 0.01$) for cows fed WCS than cows fed C, T, or FFCG. Urea nitrogen was lower ($P < 0.01$) in milk from cows fed FFCG and T than those fed WCS. Concentrations of transvaccenic acid (TVA) were greater ($P < 0.01$) in milk from cows fed WCS, T, and FFCG than cows fed C, and FFCG increased TVA more ($P < 0.02$) than WCS or T. Conjugated linoleic acid (CLA) content was higher ($P < 0.01$) in milk from cows fed WCS, T, and FFCG compared to C, and CLA content was greater ($P < 0.01$) in milk from cows fed FFCG than cows fed WCS or T. Total saturated fatty acids (SFA) were less ($P < 0.01$) in milk from cows fed

fat sources, and cows fed WCS and T had greater (P < 0.01) SFA in milk than cows fed FFCG. Polyunsaturated fatty acids were greater (P < 0.05) in milk from cows fed FFCG than those fed C, WCS, or T.

Key Words: Full-fat Corn Germ, Whole Cottonseed, Conjugated Linoleic Acid

341 The effect of varying amount of fat supplementation on the performance of lactating dairy cows.

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Dairymen and nutritionist feeding high producing cows have shown increase interest in recent years in using greater quantities of fat in their rations, especially in hand feeding systems. This is partly due to the use of cows with a high genetic potential for milk production, which requires use of rations with a high energy density in order to achieve their potential. The use of fat is desirable because it has a high energy density and it is metabolized efficiently. The positive points in high fat rations are lower body weight loss in early lactation, improved breeding efficiency, persistency of lactation and reduced dustiness of feed. The objective from this experiment was to examine the effect of animal fat on milk production, blood components, and nutrient digestibilities of Iranian Holstein cows. Eight multiparous cows were randomly assigned to a replicated 4 X 4 Latin square design. The average milk production of the cows was 31.6±3.2 kg/d and days in milk were 63±15 prior to the experiment. Every experimental period was 21 d, with 14 d for adaptation and 7 d for experimental sample collection. These animals were kept indoors in a tie stall barn. The diet consisted roughage and concentrate in a ratio of 42:58. Treatments were: 1) No added fat (control); and 2) 1.5%, 3) 3%, or 4) 4.5% animal fat. The rations were offered in two equal parts (9A.M., 5P.M.) via TMR. Animal fat was melted and mixed with concentrate before mixing with 30% alfalfa hay and 12% corn silage on dry matter bases. Fresh water was available for cows. The results showed that there was no significant effect of treatment on the DMI, rumen pH and ammonia N. The concentrations of plasma glucose or blood urea N were not significant. Milk production in different treatments was not significant: 30, 31.2, 31.6 and 32.1 kg/d, respectively. Ether extract digestibility was significant (P = 0.05) (66.8, 76.6, 80.9, 83.1), but other nutrients were similar for all treatments. Supplemented animal fat to dairy cattle rations in early lactation can improve milk production up to 6%.

Key Words: Animal Fat, Milk Production, Dairy Cattle

342 Wet corn gluten feed and alfalfa hay levels in dry-rolled corn finishing diets.

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Steers (n = 192; 351 ± 11.3 kg) were stratified by weight and assigned randomly to 1 of 24 pens (2 × 3 factorial; 4 pens/ treatment) and fed for 132-d to determine if alfalfa hay (AH) can be reduced in feedlot diets containing wet corn gluten feed (WCGF). Finishing diets contained either 0 or 35% WCGF and 0, 3.75, or 7.5% AH. Experimental diets were formulated to be iso-nitrogenous based upon the 35% WCGF and 7.5% AH treatment. DMI increased linearly when AH increased in both 0 (P < 0.07) and 35% (P < 0.01) WCGF diets. Daily gain and hot carcass weight (HCW) increased (P < 0.05) with increasing AH in diets containing 0% WCGF. Interactions for AH and WCGF were observed for ADG:DMI, fat depth, and longissimus area. Gain efficiencies of cattle fed WCGF were 7% higher (P < 0.02) than efficiencies of cattle fed no WCGF at 0% AH, suggesting a reduction in acidosis when WCGF was included. Within 35% WCGF diets, efficiency decreased as AH inclusion increased (P < 0.05). These data suggest that AH has less value when diets contained WCGF, and can be decreased from conventional levels. Efficiency was equal across AH levels when 0% WCGF was fed; however, ADG was depressed when AH was removed in diets containing 0% WCGF.

WCGF level, % DM:	0	0	0	35	35	35	
AH level, % DM:	0	3.75	7.5	0	3.75	7.5	SEM
DMI, kg[ab]	10.1	10.6	10.7	10.1	11.1	11.4	0.2
ADG, kg[c]	1.67	1.82	1.82	1.79	1.85	1.85	0.04
ADG: DMI[b]	0.165	0.171	0.170	0.177	0.166	0.163	0.003
HCW, kg[c]	360	372	372	371	375	375	4
Marbling score[d]	499	502	504	494	491	500	12
Fat depth, cm[e]	1.14	1.31	1.25	1.34	1.29	1.46	0.06

[a]Linear effect of AH within 0% WCGF (P < 0.07). [b]Linear effect of AH within 35% WCGF (P < 0.05). [c]Linear effect of AH within 0% WCGF (P < 0.05). [d]400 = Slight 0, 500 = Small 0. [e]AH × WCGF interaction (P < 0.10).

Key Words: Wet Corn Gluten Feed, Feedlot Cattle, Roughage

343 Effects of level and composition of wet corn gluten feed in steam-flaked corn based finishing diets.

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Two finishing experiments were conducted to determine the effects of level and composition of wet corn gluten feed (WCGF) in steam-flaked corn (SFC) based diets on feedlot steer performance. In experiment 1, 192 crossbred steer calves (298 kg) were stratified by initial weight and assigned randomly to 1 of 24 pens (8 steers/pen). Pens were assigned to 1 of 6 treatments (4 pens/treatment). Treatments were six levels of *Sweet Bran*® WCGF, with 0, 10, 20, 25, 30, and 35% WCGF replacing SFC (DM basis). All diets contained 10% corn silage, 5% supplement, and 3.5% tallow. Steers were implanted with Synovex C on d 0, reimplanted with Revalor-S on d 53, and fed for 151 d. Feed efficiency and ADG were similar among treatments. Dry matter intake was lower (P < 0.10) for 0% WCGF compared with levels of 20, 25, and 35% WCGF. Dry matter intake was not significantly different for treatments containing WCGF. In experiment 2, 160 crossbred steer calves (290 kg) were stratified by initial weight and assigned randomly to 1 of 20 pens (8 steers/pen). Pens were assigned to 1 of 5 treatments (4 pens/treatment). Treatments were assigned based on four ratios of steep to bran/germ meal mix in WCGF plus a negative control (CON). Wet corn gluten feed was fed at 25% of the dietary DM and was made by mixing the different components into the diet. The 4 levels of steep that comprised the ratios were 37.5, 41.7, 45.8, and 50% steep of the WCGF. All diets contained 10% corn silage, 5% supplement, and 3.5% tallow. Steers were implanted with Synovex C on d 0, reimplanted with Revalor-S on d 46, and fed for 132 d. Daily gain was similar among treatments. Feed efficiency was similar between CON and 50% steep. However, feed efficiency was decreased (P < 0.05) for levels of 37.5, 41.7, and 45.8% steep compared with CON. These data show that WCGF fed up to 35% has energy equal to SFC and the importance of the level of steep in WCGF in maintaining feed efficiency in SFC based finishing diets.

Key Words: Finishing Cattle, Byproducts, Steam-flaked Corn

344 Corn processing method and crude protein level in finishing diets containing wet corn gluten feed.

C.N. Macken*[1], G.E. Erickson[1], T.J. Klopfenstein[1], and R.A. Stock[2], [1]*University of Nebraska, Lincoln,* [2]*Cargill Inc., Blair, NE.*

Three hundred twenty crossbred steer calves (307 kg) were used in a completely randomized design finishing experiment to determine the effect of corn processing and additional urea on performance of steers fed diets containing *Sweet Bran*® wet corn gluten feed (WCGF). Steers were stratified by initial weight and allotted to 1 of 40 pens (8 steers/pen). Pens were assigned randomly to 1 of 10 dietary treatments (4 pens/treatment). The treatment design was a 5x2 factorial with factors being corn processing method (dry-rolled, DRC; fine-ground, FGC; rolled high-moisture, RHMC; ground high-moisture, GHMC; or steam-flaked corn, SFC) and CP level (13 or 14%). Observed protein levels fed were 14 and 15%. The final diet contained 60% of the respective corn, 25% WCGF, 10% corn silage, and 5% supplement. Steers were adapted to final diets in 21 d. Steers were implanted with Synovex S on d 1, reimplanted with Revalor-S on d 51, and fed for 152 d. No significant protein x grain processing interactions occurred for any feedlot performance or carcass variables. Protein level had no effect on any of the variables measured, suggesting protein requirements were met.

Grain processing method did affect cattle performance. Dry-rolled corn and FGC had similar intakes but had higher ($P < 0.01$) intakes than RHMC, GHMC, or SFC. Intakes were similar among RHMC, GHMC, and SFC. Therefore, more intense processing decreased DMI. Daily gain was similar across all treatments (average = 1.94 kg/d). Feed efficiency was improved ($P < 0.01$) by 3.8, 7.0, 8.7, or 11.8% for FGC (0.189), RHMC (0.195), GHMC (0.198), or SFC (0.204), respectively, compared with DRC (0.182). Feed efficiency was significantly different among the processing treatments, except for RHMC and GHMC. While the grains were not fed without WCGF, the large response to intensive processing suggests WCGF alleviated problems with acidosis and sorting which allowed expression of differences in energy value associated with processing.

Key Words: Finishing Cattle, Byproducts, Grain Processing

345 Effects of starch endosperm type and corn processing method on feedlot performance and nutrient digestibility of high-grain diets. C.N. Macken*[1], G.E. Erickson[1], C.T. Milton[1], T.J. Klopfenstein[1], H.C. Block[1], and J.F. Beck[2], [1]*University of Nebraska, Lincoln, NE,* [2]*Syngenta Seeds, Golden Valley, MN.*

Finishing and metabolism experiments were conducted concurrently to evaluate two starch types and two corn processing methods. For both experiments, two dent type corn hybrids were grown under similar conditions with one hybrid containing primarily vitreous endosperm (FLINT) and the other hybrid containing primarily floury endosperm (FLOUR). Corn was harvested at two different times, as high-moisture (HMC; > 28% moisture) or dry corn (DRC) and processed through a roller. Treatment design was a 2x2 factorial with factors being corn hybrid (FLINT or FLOUR) and processing method (HMC or DRC). Diets contained 81% of the respective corn, 8% alfalfa hay, 3% molasses, and 8% supplement. In the finishing experiment, 160 crossbred steer calves (291 kg) were used in a completely randomized design with 4 pens per treatment. Steers were implanted with Synovex C on d 0, reimplanted with Revalor-S on d 72, and fed a total of 191 d. The FLOUR endosperm improved ($P < 0.05$) ADG and feed efficiency compared to FLINT endosperm when fed as DRC. However, ADG and feed efficiency were similar between endosperm types when fed as HMC. Feeding FLINT as HMC improved feed efficiency by 9.5% compared to DRC and feeding FLOUR as HMC improved feed efficiency by only 3.5%. In the metabolism experiment, four ruminally fistulated steers (542 kg) were used in a 4x4 Latin Square experiment with periods consisting of 14 d adaptation and 7 d of continuous rumen pH measurement. Chromic oxide was used as a digestibility marker. The FLOUR endosperm had higher ($P = 0.06$) starch digestibility than the FLINT endosperm, while processing method had no effect. Ruminal pH change and variance were increased ($P < 0.10$) for HMC compared to DRC with no significant difference between endosperm types. These data suggest an important interaction between starch type and processing method, with less intensive processing required for corn containing less vitreous endosperm.

Key Words: Finishing Cattle, Corn Processing, Endosperm Type

346 Effect of wet distillers grains plus solubles and corn oil level on finishing heifer performance. K. J. Vander Pol*, G. E. Erickson, T. J. Klopfenstein, and C. N. Macken, *University of Nebraska-Lincoln, Lincoln, NE.*

A 113 d feeding trial was conducted utilizing 60 crossbred yearling heifers, (349 ± 9 kg) to determine if the higher energy value of wet distillers grains plus solubles (WDGS) compared to corn is due to the higher concentration of oil in WDGS. The data were analyzed as a 2 x 3 factorial arrangement of treatments, with factors being source (corn oil, or WDGS) and level (0, medium, or high). Treatments were zero fat (0F), zero WDGS (0DG), 2.5% fat (2.5F), 20% WDGS (20DG), 5.0% fat (5F), or 40% WDGS (40DG). Alfalfa hay was included in all diets at 7.5% of DM, and high-moisture corn and dry-rolled corn were fed at a 1:1 ratio (DM-basis). Corn oil or WDGS replaced corn. Diets were formulated so that 2.5F and 20DG, as well as the 5F and 40DG diets contained the same amount of EE, however, the 2.5F and 5F diets were .8% units higher in EE than the 20DG and 40DG diets, respectively, based on analysis. Heifers were individually fed, weighed every 28 d, and implanted on d 28 with Synovex-Plus. Data were analyzed using the mixed procedures of SAS, using previous ADG as a covariate. There were no significant differences observed ($P > 0.10$) for the main effects or interaction for initial weight, final weight, hot carcass weight, or yield grade. Significant interactions were observed ($P < 0.10$) for ADG, and feed efficiency. Looking at the simple effects, there was a linear decrease in ADG and feed efficiency as corn oil in the diet increased. Overall, increasing the level of fat in the diet by the addition of corn oil, reduced ADG and feed efficiency, while increasing the level of fat in the diet by the addition of WDGS did not affect ADG, and feed efficiency. Further, calculated from feed efficiency, the energy value of WDGS in the 20DG, and 40DG diets were 4% and 16% higher than the high-moisture corn/dry-rolled corn control. From these data, we were unable to determine if the higher concentration of corn oil in WDGS is responsible for the higher energy value of WDGS compared to corn.

Key Words: Wet Distillers Grain plus Solubles, Corn Oil, Feedlot Cattle

347 Seasonal effects of growth promotants on blood metabolites in feedlot heifers. W. M. Kreikemeier* and T. L. Mader, *University of Nebraska.*

Growth promoting agents may alter metabolic rate in beef cattle, thus product efficacy may vary with season. Thyroid hormones (triiodothyronine, T_3 and thyroxin, T_4; ng/ml), urea nitrogen (UN; mg/dl) and IGF-1 (ng/ml) concentrations were measured in summer and winter. Yearling heifers (n = 9 head/pen) were allotted to twelve pens in both December and June. Initial BW was 379 and 385 kg in December and June, respectively. Pens were assigned to one of six growth promotant treatments; control (C, no growth promotant), estrogenic implant (E), androgenic implant (trenbolone acetate; TBA), E + TBA (ET), melengesterol acetate (MGA), and ET + MGA (ETM). Blood samples were collected from the same four heifers/pen/study on d 0, 28, 56, and 84 via jugular puncture. Concentrations of IGF-1, T_3 and T_4 were increased ($P < 0.05$) in winter (105.0, 1.5 and 70.1 ng/ml) vs summer (92.2, 1.1, and 63.0/ml) but UN concentration was not altered (13.6 vs 14.0 mg/dl; $P > 0.05$). Estrogen + TBA and ETM reduced UN concentration by 2.0 ng/ml and increased IGF-1 concentration by 17.6 ng/ml when compared to other treatments ($P < 0.01$). When averaged across season, treatments did not alter T_3 or T_4 concentration. A season by treatment interaction ($P < 0.01$) indicated ET increased T_3 in winter but had no effect on T_3 in summer. However, E, TBA, MGA, and ETM did not effect T_3, T_4, UN or IGF-1 concentration in either season ($P > 0.05$). Based on pooled data of implant treatments only, IGF-1 concentration peaked on d 28 and declined to baseline on d 56 in winter but leveled off from d 28 to d 84 in summer (season * bleed; $P < 0.05$). Urea nitrogen concentration peaked on d 56 in winter and on d 28 in summer (season*bleed; $P < 0.05$). Metabolic rate was increased in winter vs. summer based on T_3 and T_4 concentration. During the summer, exogenous steroids maintained elevated IGF-1 levels from d 28 to 84 suggesting higher metabolic rate in winter resulted in faster exogenous steroid payout.

Key Words: Growth Promotants, Feedlot Heifers, Season

348 Evaluation of initial implants on performance and carcass quality in feedlot heifers. T. B. Farran*[1], G. E. Erickson[1], T. J. Klopfenstein[1], G. Sides[2], B. Dicke[3], and J. S. Drouillard[4], [1]*University of Nebraska-Lincoln,* [2]*Intervet, Inc.,* [3]*Cattlemen's Consulting,* [4]*Kansas State University.*

A commercial feedyard experiment was conducted to compare a new low-dose implant to a more traditional high-dose product as the initial implant for feedlot heifers. Heifers (n = 1,124; initial BW = 278 kg) were implanted with either Revalor-IH® (Rev-IH; 8 mg estradiol, 80 mg TBA) or Synovex-H® (Syn-H; 20 mg estradiol benzoate, 200 mg testosterone propionate) at initial processing. Each group of incoming cattle constituted a treatment replication, providing a total of six replications per treatment (12 pens total). Heifers were kept separate by arrival date and assigned to treatment by every other animal during initial processing. After processing, pens were immediately group weighed to establish initial weight of the pen prior to experiment initiation. Replicates of heifers were reimplanted with Revalor-200® (20 mg estradiol, 200 mg TBA) as the common terminal implant 81 d (range 69 to 85 d) prior to slaughter. Cattle were fed for an average of 177 d (range 147 to 202 d). DMI was similar between treatments. Implanting heifers initially with Rev-IH improved feed efficiency (0.190 vs. 0.186; $P = 0.03$) and tended to increase ADG ($P = 0.10$) with a 4-kg difference ($P = 0.15$) in hot carcass weight compared to heifers implanted with Syn-H. Furthermore, Rev-IH implanted heifers had higher marbling scores ($P < 0.07$), with

8.7% more carcasses (P = 0.02) achieving the upper two-thirds Choice category compared to heifers initially implanted with Syn-H. Fat depth and longissimus area were not different (P > 0.25), but calculated yield grades were higher for heifers administered Rev-IH (2.60 vs. 2.71; P = 0.09). Syn-H heifers contained 29.0% empty body fat compared to 29.4% for Rev-IH implanted heifers (P = 0.12). Results indicate that in commercial feedlot size pens, Rev-IH can improve feed conversion, marbling scores, and carcass quality with no negative impact on growth performance.

Key Words: Implants, Feedlot Heifers, Carcass Quality

349 Relationships of chute-side measurements to carcass measurements. J.C. MacDonald*, T.J. Klopfenstein, G.E. Erickson, C.N. Macken, and J.D. Folmer[1], [1]*University of Nebraska - Lincoln.*

Three data sets were compiled to determine relationship of body weight (BW), hip height (HH), and ultrasound fat thickness (FTU) to hot carcass weight (HCW) and carcass fat thickness (FTC). Data set one (DS1) included every steer calf from a herd (n = 41). Data set two (DS2) included steers (n = 200; BW = 366; SD = 19 kg) on a 112d feeding trial in which no treatment differences were expected or observed. Steers on this trial had been sorted to meet a specific weight range. Data set 3 (DS3) related initial weight and reimplant weight to HCW in calf-fed steers. DS3 includes steers (n = 352; BW = 285; SD = 22 kg) from three calf-fed trials. Steers were included in the data set if was similar to control treatments within trial. Relationships were established using correlation coefficients which were considered to be significant at $P = 0.05$. DS1 indicated that birth weight is not related to HCW or FTC. The relationship of BW to HCW improved from winter period to summer period and feeding period (r = 0.71, 0.82, 0.81, respectively). HH was a less precise indicator of HCW during winter period (r = 0.32) and finishing period (r = 0.50) and was not an indicator of HCW during grazing period. HH was not an indicator of FTC. FTU was related to HCW during grazing period only (r = 0.55), and was related to FTC during grazing and finishing periods (r = 0.51 and 0.53, respectively). DS2 suggests that relationship of BW to HCW improves with time on feed and is not an indicator of FTC. The relationship of HH to HCW does not greatly change during finishing period (r = 0.43 to 0.50) and is not related to FTC. The relationship of FTU to FTC ranged from r = 0.47 to 0.50 during finishing period. DS3 suggests that relationship of BW to HCW improves from initial weight to reimplant weight (r = 0.18 and 0.76, respectively). BW is the best indicator of HCW and FTU is the best indicator of FTC. Relationships for both measurements improve as marketing date approaches.

Key Words: Ultrasound, Hip Height, Carcass Characteristics

Teaching

350 The University of Missouri internship in reproductive management of beef cattle. J. E. Stegner*[1], T. A. Strauch[1], J. E. Williams[1], P. A. Kunkel[2], K. D. Switzer[2], R. F. Hill[3], D. E. Broek[3], D. J. Patterson[1], and M. F. Smith[1], [1]*University of Missouri, Columbia,* [2]*KABA/Select Sires, Louisville, KY,* [3]*Cache Valley/Select Sires, Logan, UT.*

Internships provide students with the opportunity to develop critical thinking and problem solving skills. An internship program was developed in cooperation with Select Sires, Inc., and the University of Missouri-Columbia (F.B. Miller Endowment Fund) to provide students with practical training in reproductive management of beef cattle. [Update of J. Anim. Sci. 77: (Suppl.1): 276]. Objectives of the internship are: 1) to provide students with practical training in the development and execution of estrus synchronization (ES) and artificial insemination (AI) programs, and 2) to provide extensive hands-on experience in ES, estrus detection (ED), semen handling (SH), and AI. Most students do not have prior experience with the preceding techniques before the internship. Students are required to attend weekly classroom or on-farm training sessions, and a 3 d Select Sires AI training school. Other responsibilities include: formulating a statement of specific learning objectives, a written protocol of overall plans, and participation in ES, ED, SH, and AI on designated farms and ranches. Students accompany AI industry personnel to assist in on-site ES, ED, SH and AI, and are exposed to diverse beef production systems. Over the past 5 years, 66 students have participated in ES, ED, SH and AI on beef farms and ranches in CO, IA, IN, KY, MO, MT, ND, NE, OR, SD, and WY. Students have worked with approximately 90,000 heifers and cows on farms and ranches in these various states. Student-faculty interaction and student-producer interaction is facilitated through the internship. Participation fosters a greater working appreciation of beef cattle reproductive management, creates ties for students with allied industry, and expands career opportunities following graduation.

Key Words: Internship, Estrus Synchronization, Artificial Insemination

351 Mastering dairy farm management issues through case based experiential learning. S.G. Wedemeier* and L.L. Timms, *Iowa State University.*

Our goal was to utilize case based experiential learning where students could gain skills in records analysis, goal setting, and troubleshooting dairy management issues. The initiation of this project idea started with a high SCC problem in the student's home dairy herd. Following an on farm troubleshooting visit, the student focused on understanding and interpreting dairy records for the herd in all dairy management areas. The student developed a list of goals and expectations to later serve as an evaluation template. An initial bottleneck (mastitis / SCC) was chosen to focus on. The student began by reviewing and interpreting weekly assigned subject matter materials. Each month the dairy herd records were analyzed and discussed one-on-one with the instructor and a plan of action was diagramed. The student would screen problem cows and collect milk samples for bacteriological analysis the following week. Bacterial profiles were used to pinpoint farm problems and develop management strategies to be implemented at the farm as well as a topic for the weekly research meeting. This process continued until dairy herd records showed an improvement and goals for this area were met. Over 13 months, the somatic cell was decreased from 800,000 to 142,000 cells/ml with increased milk production and higher milk prices due to quality bonuses. Once this was accomplished and the student felt confident in this area, they focused on another goal or bottleneck, yet continuing to maintain or improve on the previous focus. Other areas addressed have been herd breeding, nutrition, and housing programs. Gradually the student began to maintain several goal focuses at one time, thus simulating the stresses and challenges of the production dairy and having to cope with environmental and seasonal influences. The constant variables challenged the student to become more involved and creative with trial and error solutions. In reflection of his experiences, the student became more involved in the family dairy, allowed for better communication between future partners, transfer of some management level decisions to the student, increased trust and understanding between family members, and provided directional goals for the future.

Key Words: Case Based, Experiential Learning, Dairy Management

352 Retention of non-traditional agriculture students in animal sciences. M. Diekman*, B. Delks, and R. Allrich, *Purdue University.*

In the fall of 2001 and 2002, entering freshmen in the Department of Animal Sciences (ANSC) initially indicated the following options within the department: agribusiness, 8%; science, 75%, production/management, 13%; and products, 4%. Within the science option, 52% of the students (75% female, 25% male) are majoring in pre-veterinary medicine with the majority interested in companion animals. In March, 2002, 53.6% of 125 ANSC majors indicated they had an interest in companion animals or zoo/exotic animals. Of the ANSC students that matriculated in 1996-99, approximately 40% received their B.S. degree in ANSC. Of the ANSC students that matriculated in 2000 and 2001, 48.4 and 67.9% of ANSC students have remained ANSC majors, respectively. Of the students that transferred from ANSC in 2001-02, 23 of 48 (48%) and 15 of 28 (54%) remained in the School of Agriculture, respectively. With support from the Lilly Endowment, Inc., a freshmen orientation class was developed and required for ANSC majors in 2000. Topics for the course include: creating an on-line resume, preparation of plan of study,

interaction with senior undergraduates and faculty, and participating in an overnight trip visiting animal enterprises. In addition, retention efforts of freshmen have been enhanced by the availability of Animalia, a program that offers a living/learning community to agriculture students. Students in Animalia reside in the same residence hall and are clustered in English, Animal Sciences and Biology courses. Employment summaries indicate an increase in the number of jobs obtained in the non-traditional careers in the past four years. In 1999-2000, only two graduates accepted positions in the exotic or companion animal areas while 10 students accepted similar positions in 2001-02. Membership in Purdue Zoo Club has grown to more than 25 members. With the addition of two companion animal courses and a specialization in well-being/behavior, the curriculum should be more conducive to non-traditional ANSC students completing their degree in ANSC.

Key Words: Curriculum, Animal Sciences, Companion animals

353 Integrating practical elements into a theoretical applied animal behavior course for Animal Science undergraduates. K Laughlin*[1] and A.J. Zanella[1], [1]*Michigan State University*.

The teaching of applied animal behavior is of increasing importance to Animal Science undergraduates in North American universities. Building on the growing interest in animal welfare, and the potential opportunities for research and employment in this field, it is essential to deliver a body of students with a high level of knowledge, expertise and interest in this area of study.
The theoretical teaching of applied animal behavior principles in the classroom can be optimized by the integration of practical laboratory sessions, utilizing the wide range of facilities and livestock on hand at most Land Grant universities in the US. We have developed a curriculum, in which parallel weekly laboratory sessions first familiarize students with the fundamental techniques of behavioral observation, including sampling and recording methods. Subsequent sessions gradually introduce greater complexity of experimental design, formulating and testing hypotheses, statistical analysis of data and interpretation of results. Throughout these lessons, we focus on different aspects of behavior (e.g. reproductive behavior, fear responses, social organization and motivation), thus consolidating information presented in lectures, whilst providing hands-on interaction with a variety of farm animal species. In collaboration with other organizations, we are also able to educate students on behavior and welfare issues of captive wild and companion animal species.

Students are required to submit reports throughout the course, which are graded on, among other things, the standard of scientific writing and critical evaluation of the study. The final assignment is an in-depth field research project, presented in written and oral form, allowing individuals to utilize the range of tools and techniques acquired during the semester, including peer review.

We propose that such an integrated teaching approach enhances the understanding of the theory underlying applied ethology, maximizes the appreciation of the practical considerations necessary in research, and stimulates a level of interest that may not be attained solely in the classroom.

Key Words: Animal Behavior, Undergraduate Teaching, Practical Experience

Undergraduate Student Competitive Research Papers

354 Injury levels of sows in gestation: stalls vs. group housing. K.G. Bhend* and G.W. Onan, *University of Wisconsin River Falls*.

In order to address increasing public concern about housing of gestating sows, alternative systems need to be investigated. It is imperative that quantitative objective data comparing sow welfare from various housing systems be obtained. This study compared traditional confinement stalls to an alternative group housing system with electronic sow feeders (ESF). In order to quantitate sow welfare an injury scoring system was established using a linear scale that accounted for location, number, and depth of injuries. The injury scores of pregnant sows housed in stalls (100 sows) and in dynamic groups in pens with ESF (100 sows) were recorded over a period of 60 days. Scores were compared in order to determine whether there were any differences in injury incidence and severity between sows in stalls verses pens with ESF. Total injury scores were found to be significantly higher in pens ($P < 0.001$). Regression analysis of injury levels and body weight was also performed. As body weight of sows in stalls increased, injury scores increased ($P < 0.01$). There was no significant effect of body weight on injury levels of sows in pens, however there was a trend toward decreasing total injuries with increasing weight. When injury scores were compared in the dynamic pens, it was found that subsequent groups of sows added to pens had higher levels of injuries than the initial groups ($P < 0.01$). Two of the touted benefits of group housing of gestating sows include greater freedom of movement and greater opportunity for social interaction. The increased injury levels that result from aggressive social interaction, however, may offset any benefits.

Key Words: Sow Gestation Housing, Injury, Group Pens

355 Performance of *HMGA1* as a candidate gene for growth traits in the pig. N. T. Nguyen*, K. S. Kim, H. Thomsen, J. Helm, and M. F. Rothschild, *Iowa State University*.

Quantitative trait loci (QTL) analyses using molecular markers have successfully detected several important genomic regions for growth and fatness traits in pigs. Knowledge of individual genes associated with human obesity may be important to understanding variation in the pig by providing candidate genes for growth and fatness traits. Our specific interest has focused on pig chromosome 7 (SSC7), which has been assigned several significant fat QTL. The improved comparative map between human and pig chromosomes has revealed large homology between the QTL regions of SSC7 and human chromosome (HSA) 6 as well as HSA15. A positional and biological candidate gene, the <i>high mobility group A1 (*HMGA1*) gene was studied as the *HMGA1* is involved in the regulation of cell growth and differentiation. Especially, the *HMGA1* protein may play a role in reducing adipocyte cell hyperproliferation. The *HMGA1* gene was then mapped to a position within the backfat and growth QTL region identified in a Berkshire x Yorkshire family. A single nucleotide polymorphism (SNP) identified in the gene was significantly associated with observed variation in F2 animals of a Berkshire x Yorkshire family, for backfat and growth traits using single marker analyses. Phenotypic associations of this polymorphism were also found to exist in several commercial populations. Our results suggest that the *HMGA1* gene is a good candidate for the growth and fat QTL reported in this region. Furthermore, this gene could be useful for marker-assisted selection of growth and fat traits in the pig.

Key Words: *HMGA1*, Pig Chromosome 7, Candidate Gene

356 Effect of d α-tocopherol alcohol or acetate in water soluble or emulsified form to the drinking water of weanling pig. T.A. Specht*[1], D. C. Mahan[1], N. D. Fastinger[1], and R. L. Stuart[2], [1]*Ohio State University, Columbus, OH,* [2]*Stuart Products, Bedford, TX*.

A study involving 80 weanling pigs evaluated the effects of d α-tocopherol in alcohol or acetylated form added to the drinking water in a water soluble or emulsified form. The experiment was a 2 x 2 + 1 factorial conducted in four replicates as a RCB design. Vitamin E source (d α-tocopherol or d α-tocopheryl acetate) was the first factor while the second evaluated each in an emulsified or water-soluble form. A fifth group did not receive supplemental vitamin E in the diet or drinking water. Pigs were fed conventional nursery diets with 5% added fat and no supplemental vitamin E. Tap water served as the water source, but vitamin E was added to each group at 100 IU/L. Water mixtures were prepared daily, maintained at 4 °C, added as needed, with water disappearance calculated weekly. Pigs (18 ± 1 d) were allotted to treatment pens based on weight and litter. Blood was collected at weaning and weekly for a 28-d period. Serum was analyzed for α-tocopherol and triglyceride concentrations. The results showed that vitamin E source had no effect on ADG or ADFI. Pigs consuming the water soluble form of vitamin E tended to have higher gains ($P < 0.05$) and higher feed

intakes (P < 0.05) than the emulsified form. Serum α-tocopherol declined from weaning to 28-d in the control group. The pigs on vitamin E treatments had higher (P < 0.01) serum α-tocopherol from 7- to 28-d than the control group. The emulsified form of d α-tocopherol form had higher serum α-tocopherol concentrations than the water-soluble form at each measurement period but was significant (P < 0.05) only at d 7 and 14. Serum triglycerides declined from weaning to 7 d postweaning and then increased steadily to 28 d. Serum triglyceride was not affected by vitamin E treatment. These results suggest that providing vitamin E in the drinking water of weanling pigs was effective in improving their vitamin E status and the emulsified form seemed to be superior.

Key Words: Vitamin E, Weaning, Pigs

357 Feeding behavior of finishing boars and gilts on electronic feeders.

A. M. Crock*, D. S. Casey, and J. C. M. Dekkers, *Iowa State University, Ames, Iowa* .

Feed efficiency is related to and can be improved by selecting for feeding behavior traits. Sex differences must be quantified and accounted for to accomplish this. The objective of this study was to evaluate differences in feeding behavior between boars and gilts at the end of the finishing period. Feeding behavior data was collected using single space electronic feeders on 221 littermate Yorkshire boars and gilts in seven contemporary groups over the last four weeks prior to the first pig being taken off-test. Intake and occupation time were recorded for each visit. The average number of pigs per pen was 11.4 and 12.4 for gilts and boars. Mean body weight was 67.6 and 92.3 kg at the beginning and ending of the four week period. Diurnal distributions of feed intake, number of visits, and occupation time were similar between boars and gilts, except the frequencies for boars were larger in the early morning and smaller during the peak periods of the day. Means per pig for feed intake per visit, occupation time per visit, feeding rate per visit, daily feed intake, number of visits, and occupation time per day were analyzed with a mixed linear model that included the fixed effects of sex and group, the covariates number of pigs per pen, beginning body weight, and ending body weight, and the random effects of pen and litter. Sex differences were not significant (P<0.10) for all traits except for feed intake per visit, but trends were consistent with literature: boars had less frequent but longer visits and ate more feed per visit and at a faster rate. In conclusion, sex differences in feeding behavior at the end of the finishing period seem consistent with differences reported in the literature for the entire grow-finish period. These results indicate that sex differences must be accounted for when selecting for feeding behavior traits to improve feed efficiency.

Key Words: Feeding Behavior, Sex Differences, Pigs

358 Effects of field peas inclusion on intake and digestion in beef steers fed medium concentrate diets.

G.J. Williams*, S.A. Soto-Navarro, M.L. Bauer, G.P. Lardy, D. Landblom, and J.S. Caton, *North Dakota State University, Fargo*.

Four ruminally and duodenally cannulated steers (703.4 ± 41 kg initial BW) were used in a 4 x 4 Latin square to evaluate effects of field peas inclusion on intake and site of digestion in beef steers fed 55% concentrate diets. Steers were fed ad libitum at 0700 and 1900 daily and were allowed free access to water. Diets consisted of 45% grass hay (6.8% CP) and 55% concentrate mixture. Treatments consisted of: 1) control, no peas; 2) 15% peas; 3) 30% peas; and 4) 45% peas in the total diet, with peas replacing wheat middlings, soybean hulls, and barley malt sprouts in the concentrate mixture. Experimental period consisted of a 9-d diet adjustment period followed by a 5-d collection period. During collections, fecal output was measured using fecal bags, and duodenal samples were taken twice daily from all steers as follow: d 2, 0630 and 1230; d 3, 0800 and 1400; d 4 0930 and 1530; and d 5, 1100 and 1700. Total DMI (15.0, 13.7, 14.0, 13.2 ± 0.5 kg/d) and OMI (13.5, 12.3, 12.6, 11.9 ± 0.4 kg/d) decreased (P =0.05) linearly with pea inclusion. Apparent ruminal CP digestibility (17.3, 11.8, 0.9, 6.6 ± 3.3%) and true ruminal CP digestibility (54.0, 49.0, 38.0, 45.0 ± 3.1%) decreased ($P \leq$ 0.03) linearly with increasing field peas. Neutral detergent fiber intake (8.9, 7.9, 7.8, 7.0 ± 0.3 kg/d) and fecal NDF output (3.1, 2.9, 2.6, 2.3 ± 0.2 k/d) decreased linearly ($P \leq 0.03$) with increasing field peas. Acid detergent fiber intake (5.0, 4.6, 4.3, 3.8 ± 0.1 kg/d) and fecal ADF output (1.8, 1.7, 1.5, 1.4 ± 0.1 kg/d) decreased linearly ($P \leq 0.03$) with increasing field peas. No effects were observed ($P \geq 0.05$) for microbial efficiency or total tract digestibility of OM, CP, NDF and ADF. Inclusion of up to 45% field peas to beef steers consuming medium concentrate diets reduces apparent ruminal and true ruminal CP digestibility, tends to reduce DMI but does not alter OM, NDF, or ADF digestibility.

Key Words: Field Pea, Digestibility, Cattle

359 Comparison of tylosin and pharmacological zinc on acute phase reactant proteins and minerals.

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Growth and health are improved by feeding an antibiotic (Ab) or pharmacological Zn as Zn oxide (ZnO) in nursery diets. During stress, acute phase reactant proteins (APP) initiate metabolic changes including plasma mineral concentrations. Our objective was to determine effects of dietary pharmacological Zn and/or the Ab, tylosin, on growth, serum and hepatic mineral (Zn, Fe, and Cu) concentrations and APP activity. Crossbred pigs (n = 80) were weaned (7.1 kg, 19.7 d) and allotted by weight, sex and litter to dietary treatments fed in two phases (P1: d 0-7; P2: d 8-14). Diets met NRC (1998) recommendations and were as follows: 1) Control (C) 150 ppm Zn; 2) C + 2,000 ppm Zn; 3) C + Ab (tylosin, 88 g/kg); or 4) C + 2,000 ppm Zn + Ab. From d 15-27 pigs were fed a common diet (P3) with 150 ppm Zn and no Ab. Four pigs per treatment were bled on d 1, 4, 7, 11, and 14 postweaning for determination of plasma alpha 1-acid glycoprotein (AGP), an APP. These pigs were killed on d 14 and liver tissue was harvested. All pigs were bled on d 1, 7, 14, and 27 post-weaning for determination of another APP, plasma ceruloplasmin (Cp), and Zn, Fe, and Cu concentrations. Feed disappearance and pig weights were recorded at dietary changes. After 14 d of Zn supplementation, pigs fed 2,000 ppm Zn had improved (P < 0.03) ADG and G/F compared with pigs fed 150 ppm Zn. Adding Ab did not alter these parameters. Pigs fed 2,000 ppm Zn had higher (P < 0.05) Cp activity than those fed 150 ppm Zn (0.206 vs 0.188 U/mL respectively), whereas AGP was not affected by Zn or Ab. Plasma Zn and Fe were greater (P < 0.001) in pigs fed the pharmacological Zn diets than in pigs fed 150 ppm Zn with or without Ab (163 vs 58 g/g respectively). Hepatic Zn concentrations were 2.5-fold greater (P < 0.004) in pigs fed 2,000 ppm Zn compared with those fed 150 ppm Zn with or without Ab. Because Zn and Ab had different effects on the variables studied, we conclude that these two growth promoters function by different mechanisms.

Key Words: Acute Phase Reactant Protein, Zinc, Antibiotic

360 Effects of whole or rolled sunflower seeds on in situ ruminal disappearance in steers fed grass hay.

D. M. Spickler*, T. C. Gilbery, M. L. Bauer, and G. P. Lardy, *North Dakota State University, Fargo*.

Nine ruminally cannulated crossbred steers (619 ± 25 kg) were used to evaluate effects of fat from sunflower seeds on fiber digestion and differences between whole and rolled sunflowers on in situ disappearance of hay and sunflowers. Steers were offered grass hay ad libitum (7.3% CP; 70.8% NDF) and were given 2 wk to adjust to dietary treatments. Treatments were sunflower meal (control; 0.15% of BW), whole sunflower seeds (0.25% of BW), and rolled sunflower seeds (0.25% of BW). Sunflower meal and sunflower seed treatments provided equal protein. Added dietary fat from sunflower seeds was 4.94% for rolled and 5.51% for whole (DM basis). Hay (2-mm grind; 5 g/bag) was incubated ruminally in situ for 96, 48, 36, 24, 12, 8, 4, 2, and 0 h and analyzed for DM, CP, NDF, and ADF. Whole and rolled sunflower seeds were masticated by ruminally evacuated steers, retrieved, and freeze dried. Masticated sunflower seeds (5 g) were incubated for 48, 36, 24, 12, 8, 4, 2, 0 h, and analyzed for DM, CP, ether extract (EE), and ADF. In situ data were fit to the model: disappearance = a + b × $e^{(-kt)}$; where a and b = rapidly and slowly degraded fractions, k = disappearance rate, and t = time. Hay intake (1.56 ± 0.11% of BW) was not different (P = 0.53) among treatments. In situ disappearance rate of hay DM (3.90 ± 0.44 %/h), CP (4.09 ± 0.35 %/h), NDF (3.72 ± 0.42 %/h), and ADF (3.85 ± 0.52 %/h) was also not different ($P \geq 0.10$) among treatments. Rolling sunflower seeds increased ($P \leq 0.002$) rate of sunflower seed DM (7.18 vs 0.89 ± 0.30 %/h), CP (8.25 vs 1.98 ± 0.43 %/h), and EE (6.57 vs 1.15 ± 0.55 %/h) disappearance compared with whole sunflower seeds.

Rolling sunflower seeds did not affect ($P = 0.51$) sunflower seed ADF disappearance rate (6.77 ± 3.79 %/h). Rolling sunflower seeds increased rate of ruminal digestion. Feeding oil in the form of raw sunflower seeds does not appear to affect ruminal fiber digestion. Increasing rate of ruminal oil release by rolling sunflowers also does not appear to affect ruminal fiber digestion.

Key Words: Sunflower Seeds, Supplementation, Cows

361 Controlling staphylococcus aureus and other mastitis and lowering somatic cell counts in a modern freestall dairy. S.G. Wedemeier* and L.L. Timms, *Iowa State University*.

Strategies based on monthly dairy herd record evaluations and strategic milk bacteriological culturing for control of Staph. aureus (SA), other intramammary infections, and somatic cell counts (SCC) were implemented and evaluated in a 95 cow modern freestall dairy in northeast Iowa during a 13 month period (March 2001-April 2002). The initial herd SCC was 800,000 cells/ml with 32% of the herd > 350,000 and 67% of these animals with high SCC > 3 months (herd SCC > 1 million three times prior to project initiation due to winter weather teat damage and fresh animal mastitis). Aseptic milk samples from all quarters of 76 cows were taken at milking time and examined for mastitis pathogens using National Mastitis Council protocols. Initial cultures showed 16% of cows and 5% of quarters with SA, and 3%, 3%, and 2% of quarters infected with environmental streps, coagulase negative staph. and pseudomonas , respectively. A monthly monitoring program was established which consisted of evaluating monthly DHI-SCC records via computer, conducting a California mastitis test on all high SCC cows at milking, and culturing all CMT positive quarters. Based on cultures, monthly strategies were developed to prevent and treat infections. All SA infected animals were segregated and milked as a separate group. Milking equipment and procedures were reviewed and modified to prevent spread. Approaches to therapy of SA included culling select cows and targeted multiple dry treatments. Implemented strategies to address the environmental mastitis problem, particularly during the dry period, were changing the facility that transition animals were housed in, core antigen vaccines, and dry cow teat dip sealants. Modifications to lactating free stalls included increased bedding amounts and lower brisket boards. Somatic cell counts in October 2001 were 325,000 with low rates of new infections. In April, 2002, herd SCC was 143,000 with only 7 animals > 350,000 SCC. Mastitis prevention and therapy strategies based on timely milk quality records interpretation coupled with targeted bacteriology resulted in significantly lower cell counts, increased milk production, and higher milk price due to higher quality premiums.

Key Words: Mastitis, Somatic Cell Counts, Staphylococcus Aureus

362 Determining time of intramuscular fat deposition using ultrasound data. C.A. Urdahl*[1], J.J. Harlan[1], G.A. Younglove[1], S. Nash[2], S. Harrison[2], J. Packham[2], R. Panting[2], D.M. Sanchez[3], and J. Findlay[2], [1]*Chadron State College, Chadron, NE,* [2]*University of Idaho Cooperative Extension, ID,* [3]*University of Wyoming Uinta County Extension, Evanston, WY*.

The ability to predict when market cattle move from select quality to choice quality grade would assist feeders in preventing over feeding of market cattle and thus reduce costs and possibly increase profit. Ultrasound technology has been used in the livestock industry for almost 50 years. However, most studies looking at intramuscular fat (IMF) deposition over time on feed have utilized different animals for measurements as steers were harvested in order to measure IMF. Thus, this study was conducted to evaluate IMF deposition over time utilizing ultrasound measurements. Fifty-seven crossbred steers were fed a traditional feedlot ration designed for growth to market weight within 150-160 days on feed. Intramuscular fat was measured using real time ultrasound on approximately days 60, 90, 120, and 150. Data were analyzed using the general linear model of SAS appropriate for a repeated measures design. Data collected to date suggest on average market cattle deposit the largest percent of backfat between approximately day 90 and day 120 (21% increase) as opposed to the other two time periods (12-12.5% increase).

Key Words: Intramuscular Fat, Ultrasound, Fat Deposition

363 A comparison of methods for on-farm determination of failure of passive transfer of immunoglobulin to dairy calves. A. M. Harvey* and A. R. Hippen, *South Dakota State University*.

Two commercially available, qualitative, on-farm test kits (Midland Bio-Products Inc., Boone, IA), which utilize serum or whole blood to evaluate failure of passive transfer (FPT) of immunoglobulins, were evaluated using 38 Holstein calves. Results from the kits were compared with refractometry determination of serum proteins and radial immunodiffusion determinations for IgG (RID; Triple J Farms, Bellingham, WA). Blood samples were collected immediately following birth before first colostrum feeding and at 48 h. At birth, serum protein concentrations averaged 4.52 g/dl and IgG averaged 8.6 mg/dl, respectively, for refractometer and RID, respectively. Forty eight hours after feeding colostrum, serum protein concentrations averaged 6.02 g/dl and IgG concentrations were 2129.3 mg/dl. Feeding colostrum increased serum protein and IgG concentrations at 48 h ($P < 0.01$). Serum protein concentrations determined by refractometry and serum IgG determined by RID were positively and significantly correlated ($r^2 = 0.56$, $P < 0.01$) and the relationship is characterized as: serum protein, g/dl = 4.64 + 0.000672 X IgG, mg/dl. Adequate immune transfer was assumed when serum IgG concentrations were greater than 50 mg/dl or FPT with IgG less than 50 mg/dl. Using samples of blood from calves collected prior to feeding colostrum, the accuracy of the on-farm plasma kits for adequate passive transfer was 0% false negatives and 3.1% false positives. The accuracy of the whole blood kit on samples from newborn calves was 4.5% false negatives and 0% false positives. On blood samples from calves fed colostrum, the plasma kit presented 5% false negatives and 0% false positives. The whole blood kits yielded 13.3% false negative readings and 0% false positives. Thus, dairy producers can use this qualitative assessment tool to ensure that calves that test adequate for passive transfer do indeed have adequate blood IgG concentrations and avoid FPT in calf rearing systems.

Key Words: Dairy Calves, Passive Transfer, Immunoglobulin

364 Effects of selenium source and physiological state on body, heart, and liver mass, small intestinal growth, and crypt cell proliferation in female rats. B. C. Stegman*[1], J. B. Taylor[2], L. P. Reynolds[1], J. W. Finley[3], D. M. Schafer[3], and J. S. Caton[1], [1]*North Dakota State University, Fargo,* [2]*USDA, ARS, U.S. Sheep Experiment Station,* [3]*USDA, ARS, Human Nutrition Research Center, Grand Forks*.

Sixty female Sprague-Dawley rats were used to evaluate effects of Se source and physiological state on body, heart, and liver mass, small intestinal growth, and crypt cell proliferation. Treatments were arranged in a 2 x 3 factorial with dietary Se source (Se-met vs Se-cys) and physiological state (non-pregnant, pregnant, and lactating) as factors. Rats were fed Se-deficient torula yeast diets from weaning to breeding (72 d) and then supplemented to provide 2 ppm of Se from either Se-met or Se-cys. Rats were fed Se treatments for 17 d prior to necropsy. Data are reported as means pooled SEM. Body mass tended ($P = 0.07$) to be lower in rats fed Se-cys compared with Se-met (313 vs 296 6.6 g). Compared with Se-cys, dietary Se-met increased ($P = 0.04$) heart mass during lactation (1.06 vs 1.25 0.06), but not in non-pregnant or pregnant rats (Se-source x physiological state interactions; $P < 0.06$). Liver mass was not affected ($P = 0.70$) by Se source. Liver mass was highest in lactating, intermediate in pregnant, and lowest in non-pregnant rats ($P < 0.01$; 23.5 vs 15.6 vs 11.2 0.6 g). Intestinal RNA and DNA were unaffected by Se source but RNA was higher ($P < 0.01$) in lactating compared with non-pregnant or pregnant rats. Se-cys reduced ($P < 0.03$) intestinal protein (mg/g) compared with Se-met in both pregnant and lactating rats (40 vs 62 and 50 vs 89 7.1 mg/g, respectively). Intestinal DNA:RNA, protein:DNA, and crypt cell proliferation were unaltered ($P > 0.20$) by treatment. These data indicate that liver mass, intestinal RNA, and protein concentrations are impacted by physiological state. In addition, Se source influences heart mass and intestinal protein concentration. Crypt cell proliferation appears unaltered by amino acid source of Se or physiological state.

Key Words: Selenium, Intestine, Growth

365 Evaluating chute-side ultrasound accuracy in market cattle. J.J. Harlan*[1], C.A. Uradahl[1], G.A. Younglove[1], S. Harrison[2], S. Nash[2], J. Packham[2], R. Panting[2], and D.M. Sanchez[3], [1]*Chadron State College, Chadron, NE,* [2]*University of Idaho Cooperative Extension, ID,* [3]*University of Wyoming Uinta County Extension, Evanston, WY.*

Carcass measurements on market beef are becoming increasingly difficult to obtain, as processing plants are less willing or able to allow outside people into facilities to acquire carcass data. Ultrasound technology, which has been used since the 1950's, has provided producers with the ability to collect carcass data on live animals. However, predicting intramuscular fat (IMF) has not proven to be accurate with chute-side service. Thus, this study was conducted to evaluate the accuracy of new software designed to measure IMF at chute-side utilizing ultrasound. Fifty-seven crossbred market steers were fed a tradition feedlot ration designed for growth to market weight within 150-160 days on feed. Steers were measured ultrasonically using chute-side methods and Central Ultrasound Processing for 12th rib fat thickness, longissimus muscle area and percent IMF on approximately days 90 and 150. Steers were harvested five days after the second scan and carcass data collected. In addition a one-inch steak was collected from the 12-13th rib region and chemically analyzed for fat content of the longissimus dorsi muscle. Data will be analyzed utilizing the general linear model of SAS.

Key Words: Ultrasound, Chute-side Accuracy, Carcass Quality

Nonruminant Nutrition (Addendum)

366 Comparison of antimicrobial alternatives in irradiated diets for nursery pigs. T. P. Keegan*, J. M. DeRouchey, J. L Nelssen, M. D. Tokach, R. D. Goodband, S. S. Dritz, and C. W. Hastad, *Kansas State University, Manhattan.*

Previous research at Kansas State University indicated irradiation can effectively reduce the bacterial concentration in nursery diets. Our hypothesis for this research was that eliminating bacteria in the feed via irradiation would allow the impact of antimicrobial alternatives to be more easily measured. In a 27 d growth assay, 354 weanling pigs (PIC, 6.9 kg and 18 $\pm$ 2 d of age) were fed one of 9 experimental diets: 1) control diet with no antimicrobials, 2) irradiated control diet with no antimicrobials, and irradiated control diet with added; 3) Carbadox (50 g/ton), 4) Probios® (1.6% from d 0 to 14 and 0.8% from d 14 to 21), 5) BioSaf® (0.3%), 6) Biomate Yeast Plus® (0.1%), 7) Bio-Mos™(0.3%), 8) Bio-Plus® 2B (0.05%), or 9) LactoSacc® (0.2%). There were 8 pens/treatment and 5 pigs/pen. BioSaf®, Biomate Yeast Plus®, and Lacto Sacc® are all concentrated forms of selected live yeast cells while Bio-Mos™ is a mannanoligosaccharide derived from yeast. Probios® is a form of lactic acid bacteria and Bio Plus® 2B contains two bacillus strains. All antimicrobials were added after diets were irradiated. Neither irradiation nor feed additives in an irradiated-diet improved growth performance compared to the non-irradiated control. From d 0 to 27, ADG was 296, 300, 301, 290, 255, 285, 303, 295, and 284 g and Gain/feed (G/F) was 0.78, 0.79, 0.76, 0.71, 0.75, 0.76, 0.77, 0.79, and 0.76 for diets 1 to 9, respectively. Pigs fed the non-irradiated control diet, irradiated control diet or irradiated diets containing Carbadox, Bio-Mos™, or Bio-Plus® 2B had greater ADG ($P < 0.05$) than pigs fed BioSaf®. Pigs fed Probios® had a poorer G/F ($P < 0.05$) compared to all other test diets. Pigs fed the irradiated control or Bio-Plus® 2B had improved G/F ($P < 0.05$) compared to pigs fed BioSaf®. In conclusion, irradiating the control diet or adding the feed additives to the irradiated diet did not improve growth performance. Eliminating the bacteria in the control diet by irradiation did not allow the impact of antimicrobial alternatives to be more easily measured.

Key Words: Nursery Pig, Irradiation, Feed Additive