

ABSTRACTS
AMERICAN SOCIETY OF ANIMAL SCIENCE
MIDWESTERN SECTION
 March 13–15, 2000
 Des Moines, IA

* Author Presenting Paper

BREEDING AND GENETICS

1 Gene expression in hypothalamus and brown adipose tissue of mice divergently selected for heat loss. M. F. Allan*, M. K. Nielsen, and D. Pomp, *University of Nebraska*.

The objective of this study was to search for genes regulating traits related to energy balance utilizing mice selected 16 generations for heat loss (direct calorimetry). The high (MH) heat loss line has 50% greater heat loss, 40% less body fat, and 20% greater feed intake than the low (ML) heat loss line. At 11 wk, partially inbred (F=.60) males (derived from MH and ML) were measured for heat loss and placed on a 10 d feed intake trial. Inbred MH had 37% (P<.0001) increased heat loss and 20% (P<.0001) greater feed intake than ML. Mice were euthanized 3 hr after dark for rapid dissection of tissues and extraction of RNA. Differential display PCR (dd-PCR) was used to evaluate transcriptional differences between lines in hypothalamus and brown adipose tissue (BAT). Results following confirmation of dd-PCR (Northern hybridization, using dd-PCR products as probes) were increased mRNA levels of Ribosomal protein L3 (*RPL3*) (ML>MH) in hypothalamus and BAT. *RPL3* expression was also investigated using competitive RT-PCR. This confirmed the previous results, that expression of *RPL3* was greater in the hypothalamus and BAT of ML versus MH mice. *RPL3* has also been found to be overexpressed in skeletal muscle of ob/ob mice (Diabetes 47:1451-8). To determine if *RPL3* may be a quantitative trait locus (QTL) for heat loss and/or obesity, physical and linkage mapping of *RPL3* to MMU15 was accomplished using the mouse T31 radiation hybrid panel and linkage analysis in a backcross population of M16i x Castaneous mice, respectively. A previous QTL study using a cross between MH and C57BL/6J (Genetics 152:699-711; 1999) did not find evidence for loci influencing heat loss on MMU15, while many other studies have identified the potential for multiple QTL influencing body fat on this chromosome. *RPL3* may be a downstream event in a regulatory cascade initiated by a heat loss QTL. The difference of *RPL3* mRNA between ML and MH lines warrants further investigation into the overall role of *RPL3* in regulation of energy balance in mammals.

Key Words: Differential display, Mice, Heat loss

2 A Least Squares model for mapping QTL based on selective DNA pooling data. Jing Wang* and Jack Dekkers, *Iowa State University, Ames, IA*.

Selective DNA pooling is an efficient method to detect markers linked to QTL in large half-sib families based on differences in marker allele frequencies between individuals with high versus low phenotypes. Current methods of analysis are, however, based on single markers and do not allow separation of QTL position and effect. The objective of this study was, therefore, to develop and evaluate a least squares regression method to map QTL based on selective DNA pooling data from multiple markers. The following model was used: $p_{ijk} = r_k + (1 - 2r_k)p_{Qij} + e_{ijk}$, where p_{ijk} is the observed frequency for marker k in tail j from sire i, r_k is the recombination rate between marker k and a putative QTL, p_{Qij} is the QTL frequency in tail j for sire i and e_{ijk} is a residual. To map a QTL, this model is fitted for each possible position of QTL along the chromosome; the position that gives the best fit provides an estimation of QTL position. Estimates of QTL substitution effects can be estimated from associated estimates of p_{Qij} . Methods were validated by simulation using selective DNA pooling data on 6 fully informative evenly spaced markers on a 100cM chromosome from the top and bottom 5% or 10% of 2000 progenies of 7 or 14 paternal half-sib families. A QTL was simulated at 46cM from one end of the chromosome with two alleles with equal frequency and a substitution effect of 0.5 σ_p . A random technical error was added to marker frequencies to obtain observed frequencies. The following table gives means and standard deviations of QTL position estimates across 1000 replications. Nearly unbiased estimates of QTL position and QTL effect (not shown) were obtained with reasonable accuracy. Results show that the least squares model is a feasible method to map QTL based on selective DNA pooling data in large half-sib families. Further studies are needed to evaluate the power of QTL mapping with selective DNA pooling in comparison with classical selective and non-selective genotyping strategies.

selected %	5%				10%			
	7 sires		14 sires		7 sires		14 sires	
$\sigma_{tech.error}$	\bar{x}	σ	\bar{x}	σ	\bar{x}	σ	\bar{x}	σ
0.053	46.09	5.03	46.16	2.62	45.94	5.22	45.93	2.65
0.037	46.10	4.52	46.21	2.24	45.95	4.69	46.02	2.17
0.026	46.09	4.26	46.23	2.11	45.98	4.32	46.07	1.84

Key Words: QTL mapping, Selective DNA pooling

3 A preliminary genomic scan for chromosomal regions affecting plasma FSH concentrations in pubertal boars. G. A. Rohrer*, J. J. Ford, and T. Wise, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE USA.*

Meishan germplasm is a scientifically valuable addition to most resource populations looking for quantitative trait loci (QTL). The Meishan breed excels in female reproduction over most western breeds of swine as they reach puberty at an earlier age, ovulate more ova per estrus, have greater uterine capacity and produce larger litters. Despite the fact that Meishan boars have smaller testes than western pigs, their fertility is not compromised. In previous reports, Meishan boars had elevated levels of pituitary-derived glycoprotein hormones such as luteinizing, follicle stimulating and thyroid stimulating hormones (LH, FSH and TSH, respectively). To understand the genetic mechanisms underlying the increased levels of FSH in Meishan boars, a reciprocal back-cross resource population of Meishan (ME) and White Composite (WC) pigs was used. Next, 3/4 ME 1/4 WC pigs were mated to 1/4 ME 3/4 WC pigs to produce 1/2 ME 1/2 WC progeny. Multiple blood samples from 121 boars were collected during pubertal development and plasma concentration of FSH determined, 15 boars were 1/4 ME 3/4 WC, 18 boars were 3/4 ME 1/4 WC and 88 boars were 1/2 ME 1/2 WC. A total of 156 genetic markers spaced throughout the genome were genotyped across these boars and all of their ancestors in the population. A least-squares regression analysis was conducted to determine the probability of a QTL affecting serum FSH residing within a given genomic interval. Three regions reached genome-wide significance located on chromosomes 7, 8, and X. Two additional regions which merit mentioning were located on chromosomes 10 and 18. Whether coincidental or a result of pleiotropy, the region on 8 also affects ovulation rate, the region on X affects backfat thickness and testicular development, the region on 10 is between QTL for age at puberty and ovulation rate, and the region on 18 has weak evidence for an affect on ovulation rate. Further studies are ongoing to confirm these associations of genomic regions with plasma FSH as well as evaluate potential pleiotropic effects.

Key Words: QTL, FSH, Boars

4 Linkage mapping in pigs using single nucleotide polymorphisms (SNPs): I. SNP Discovery. S. C. Fahrenkrug*, B. A. Freking, G. A. Rohrer, and J. W. Keele, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE USA.*

Current livestock maps are composed primarily of anonymous microsatellite markers. Recent advances suggest single nucleotide polymorphisms (SNPs) will become the marker-type of choice for applications requiring high-throughput genotyping. We are developing a porcine genetic map based on SNPs for integration with current linkage maps. To facilitate comparative mapping efforts we will map SNPs from porcine expressed sequences tags (ESTs) orthologous to genes with known human map positions. Single-pass porcine EST sequence is subjected to automated PCR primer design with Primer 3. The results of PCR amplification from porcine, bovine, and ovine DNAs are entered into a relational database (MARCDDB). Successful primer-pairs are used to generate amplicons from nine parents of our porcine reference population, and seven animals likely to harbor breed-specific alleles present in our mapping animals. Amplicons are purified and subject to fluorescent di-deoxy sequencing. Chromatograms are imported into MARCDDB, automatically assembled into contigs, and assessed for SNPs using Polyphred. Potential polymorphisms are interactively evaluated using Consed. Validated SNPs are exported to MARCDDB for automated genotyping assay design. Preliminary assessment of our strategy for SNP-discovery reveals it to be quite efficient. Without previous knowledge of gene-structure, 40% of the primer pairs gave rise to amplicons suitable for DNA sequencing. Sequence generated from animals in our SNP discovery panel revealed that 75% of the amplicons harbored SNPs, ranging from 1 to 13 per amplicon, with an average density of 1 per 100-150 base pairs. Approximately 20% of the SNPs discovered represent simple insertion/deletion events, and were found in a majority of amplicons harboring introns. These results suggest our strategy will be effective for the discovery of a sufficient number of SNPs to develop an SNP-based, type-I genetic map for integration with existing porcine linkage maps, and direct comparison to genome maps of other species.

Key Words: Swine, SNP, EST

5 Identification of novel polymorphisms at the bovine calpastatin and insulin-like growth factor binding protein-2 loci. M. Pagan*¹, N.E. Raney¹, M. Koohmaraie², and C.W. Ernst¹, ¹Michigan State University, East Lansing, ²Roman L. Hruska U.S. Meat Animal Research Center ARS, USDA, Clay Center, NE.

Calpastatin (CAST) and insulin-like growth factor binding protein-2 (IGFBP-2) were selected as candidate genes for growth and meat quality in cattle. DNA sequence variation (polymorphism) was evaluated at these loci. Primer pairs used for the polymerase chain reaction (PCR) were designed from bovine CAST genomic DNA (Ernst et al., unpublished) and bovine IGFBP-2 cDNA sequence (GenBank accession no. 4154260). A polymorphism was identified in a 303-bp fragment of the CAST gene by single-stranded conformational polymorphism (SSCP). DNA sequencing to confirm SSCP alleles indicated an insertion of a cytosine nucleotide in the less frequent CAST allele (designated B) approximately 80 bp downstream of exon 2. Individuals from the Hereford (n = 4), Simmental (n = 5), Tarantaise (n = 3), Shorthorn (n = 5), Holstein (n = 13), Brahman (n = 6) and Angus (n = 5) breeds were genotyped for this polymorphism. Most individuals were homozygous for the A allele. However, the B allele was found to be segregating in the Simmental, Tarantaise and Shorthorn animals with frequencies for the B allele of 0.3, 0.17 and 0.8, respectively. Two restriction fragment length polymorphisms (RFLP) were identified in a 1,200-bp fragment of the IGFBP-2 gene using the restriction endonucleases *Hind III* and *Nla III*. Alleles identified following *Hind III* digestion (designated A and B) were segregating in all breeds evaluated. Allele frequencies were 0.75 A/0.25 B for Brahman, 0.1 A/0.9 B for Simmental, 0.17 A/0.83 B for Tarantaise, 0.5 A/0.5 B for Shorthorn, and 0.3 A/0.7 B for Angus animals. Alleles identified following *Nla III* digestion (designated C and D) were segregating only in the Brahman (allele frequencies 0.58 C/0.42 D) and Simmental (allele frequencies 0.9 C/0.1 D) animals. Therefore, the two IGFBP-2 PCR-RFLP are not in linkage disequilibrium as might be expected for the relatively short fragment. The CAST and IGFBP-2 polymorphisms identified in this study could potentially serve as markers for variation in expression of important beef traits such as tenderness and muscle yield. Thus, further evaluation of these polymorphisms in additional populations is warranted.

Key Words: Polymorphism, CAST, IGFBP-2

6 Identification of polymorphic loci between two pig populations using representational difference analysis. C.R. Farber*¹, N.E. Raney¹, K. Nadarajah², D.L. Kuhlers², and C.W. Ernst¹, ¹Department of Animal Science, Michigan State University, East Lansing, ²Animal and Dairy Sciences Department, Auburn University, AL.

Representational difference analysis (RDA) was performed using genomic DNA from pigs differing in genotype at the skeletal muscle ryanodine receptor (RYR1) locus. DNA samples for RDA were obtained from a Landrace pig population following five generations of selection for increased real-time ultrasound loin eye area (RTU-LEA). Genotyping at the RYR1 locus revealed frequencies for the recessive allele of 0.43 and 0.17 in the selected and control lines, respectively. RDA using the restriction endonuclease BamHI was performed using DNA from one selected line RYR1 homozygous recessive (nn) pig as tester and five pooled control line RYR1 homozygous normal (NN) pigs as driver. Following three rounds of subtractive hybridization and difference enrichment, final difference products were cloned and sequenced. Sequence analysis of seven difference products revealed that they were all unique loci. Southern blot analysis confirmed the product designated RDA13 was unique to the tester sample. A PCR based test was developed for rapid confirmation of sequences only present in the tester sample. This test identified two products, RDA5 and RDA7, as being present in both the tester and driver samples excluding these products from further evaluation. Confirmation of polymorphisms along with physical and genetic linkage mapping of these loci is currently underway. The development of RDA derived markers will contribute to the development of high resolution pig genome maps. These markers will not only aid in the mapping of quantitative trait loci (QTL), but could potentially lead to the identification of genes involved in phenotypic differences observed between pigs differing in genotype at the RYR1 locus.

Key Words: RDA, RYR1, genetic markers

7 Identification of differentially expressed genes in developing pig fetuses. S.R. Wesolowski*, N.E. Raney, and C.W. Ernst, *Michigan State University, East Lansing.*

Growth and development of pig fetuses is controlled by the coordinated expression of numerous genes. The objective of this experiment was to identify differentially expressed genes in developing pig fetuses using the differential display reverse transcription polymerase chain reaction (DDRT-PCR) technique. Pig fetuses were obtained from gilts (2-3 per stage) at 21, 35, and 45 d of gestation. Thirty-five and 45 d fetuses were divided into anterior, medial, and posterior sections. Total RNA was extracted from 3 whole 21 d fetuses and from each section of three 35 d and three 45 d fetuses. For DDRT-PCR assays, RNA samples were pooled from anterior, medial, and posterior sections for each 35 and 45 d fetus. Four primer pairs (1 oligo-dT anchor in combination with 4 arbitrary primers) were used to identify putative differentially expressed genes. Six bands that were amplified in all 3 samples of at least one age and were faint or undetectable in samples of the remaining ages were excised, PCR re-amplified, and cloned. DNA sequence analysis of subclones derived from 1 of the bands resulted in 2 distinct gene products, whereas a single product was obtained for subclones from 4 other bands. Pig complementary DNAs (cDNAs) were identified with homologies to collagen type XIV, complement component C6, and vitamin D binding protein. Three novel pig expressed sequence tags (ESTs) were also identified. Differential expression of collagen type XIV was confirmed by northern blot analysis. Abundance of collagen type XIV mRNA increased in fetuses from 21 to 45 d of gestation. These results provide new information concerning gene expression in developing pig fetuses and indicate that DDRT-PCR is a powerful technique for identifying differentially expressed genes.

Key Words: differential display, pig, gene expression

8 Porcine myostatin cDNA sequence: Comparison between Meishan, Duroc, Hampshire and Yorkshire pigs. G.R. Voelker*, J.C. Conroy, and M.B. Wheeler, *University of Illinois, Urbana, Illinois, 61801.*

Myostatin (GDF-8) is a member of the TGF- β superfamily of growth factors which is expressed predominantly in skeletal muscle. Myostatin is a purported negative regulator of muscle development. The double-muscling phenotype of Belgian Blue and Piedmontese cattle has been linked to nucleotide deletions and transitions within the coding region of the myostatin gene. The objective of this study was to compare the coding region sequence of myostatin between Meishan, Yorkshire, Duroc and Hampshire breeds of pigs. We were interested to determine if the Meishan myostatin coding region contained any sequence variations when compared to the published porcine myostatin cDNA sequence (GenBank number: AF019623) and our sequences of the more heavily muscled Yorkshire, Duroc and Hampshire breeds of pigs. Total RNA was used for RT-PCR amplification of the myostatin coding region. Two sets of primers were synthesized based on the published porcine myostatin cDNA sequence. The amplified myostatin sequence was ligated into the pCR 2.1 TA cloning vector (Invitrogen) and this ligation was used to transform INV α F competent cells. The appropriate colonies were picked, grown in culture and analyzed for the insert via BamHI restriction digestion. Samples that contained the insert were brought to the University of Illinois Biotechnology Center for sequencing using the standard M13 reverse primer. The obtained sequences were compared to the already published porcine myostatin cDNA sequence and to the other breed sequences. Sequence information was obtained from gluteus muscle samples of two Meishan, one Yorkshire, one Duroc and one Hampshire pig. Potential sequence variations were subjected to RFLP analysis for confirmation. The sequence analysis of the four different breeds showed no variations when compared to each other and to the already published myostatin sequence. These results indicate that the role of porcine myostatin as a negative regulator of muscle development is not as straight forward as it seems to be in the bovine system.

Key Words: cDNA, Meishan, Myostatin

11 Selection for lean growth rate in a synthetic line of Yorkshire-Meishan pigs 1. Selection pressure applied and direct response. P. Chen*, T. J. Baas, and J. C. M. Dekkers, *Iowa State University.*

Selection for lean growth rate (LGR) was conducted for four generations on a synthetic line of Yorkshire-Meishan pigs. In the select line, seven boars and twenty gilts with the highest LGR were selected from each generation to produce the subsequent generation. A contemporaneous control line was maintained by randomly selecting five boars and fifteen gilts to produce the next generation. Inbreeding coefficients averaged .198 and .207 for the select and control line pigs and .173 and .162 for the select and control line dams, respectively, in the fourth generation. LGR was estimated from ultrasound measures of tenth-rib backfat and longissimus muscle area from 1057 pigs. These pigs were sired by 58 boars and out of 133 sows. The generation interval was 13 months and average selection differential per generation was 1.1 phenotypic standard deviation units. Heritability and selection response were estimated from the deviation of the select line from the control line (method 1) and multiple trait derivative free restricted maximum likelihood (MTDFREML) (method 2) on the same data. Realized heritability was $.29 \pm .12$ for LGR using method 1. The corresponding estimate from method 2 was .32. The estimate of direct genetic change per generation using method 1 was 9.4 g/d for LGR. The corresponding estimate from method 2 was 10.5 g/d for LGR. Selection for LGR was effective in a synthetic line.

Key Words: Pigs, Selection responses, Lean growth rate

12 Relationship of two PCR-RFLPs in the bovine calpastatin gene with calpastatin activity, meat tenderness, and carcass traits. H. Y. Chung*¹, M. E. Davis¹, H. C. Hines¹, and D. M. Wulf², ¹The Ohio State University, ²South Dakota University.

Relationships of the calpastatin system with calpastatin activity, meat tenderness and carcass traits were examined in 47 purebred Angus bulls from EORDC (Eastern Ohio Resource Development Center). Two lines were divergently selected for blood serum IGF-I concentration. Genotyping was performed by PCR-RFLP analysis at the calpastatin locus. Following the selection of PCR primers based on the bovine cDNA sequences, one set of primers was generated from calpastatin domain I (CAST67), and a second set from domain IV (CAST28). Bulls approximately 13 to 15 mo of age were slaughtered, and carcass traits, including fat thickness (FAT), longissimus muscle area (LMA), percentage of kidney, pelvic and heart fat (KPH), hot carcass weight (HCW), marbling score (MAR) and quality grade (QUL) were measured. The activity of calpastatin (CAC) was measured, and Warner-Bratzler Shear Force (WBS) was determined. The statistical model for this analysis included fixed effects of calpastatin genotypes, age of dam, IGF-I selection line, and a covariate for age of bull. Genetic polymorphisms among individuals were observed for both loci (AA, AB, and BB). Significant differences between CAST67 genotypes were found ($P=.04$) for FAT, and CAST28 genotypes influenced KPH ($P=.05$). All of the measurements tended to show higher values in the high IGF-I line than in the low IGF-I line, but no significant differences were found between lines. Least significant differences among CAST67 and CAST28 genotypes were found at the $P=.05$ level for FAT (BB>AB>AA) and KPH (BB>AB>AA), respectively. Positive relationships were detected between MAR and KPH with $r=.37$ ($P=.19$), and between FAT and HCW with $r=.43$ ($P=.13$). Negative relationships were detected between CAC and FAT with $r=-.47$ ($P=.08$), and between CAC and KPH with $r=-.60$ ($P=.02$). It may be possible to use calpastatin genotypes classified by PCR-RFLP in marker assisted selection programs to improve carcass traits.

Key Words: Calpastatin, Carcass Traits, PCR-RFLP

13 Effects of the calpain system on the growth of Angus bulls. M. E. Davis*¹, H. Y. Chung¹, H. C. Hines¹, and D. M. Wulf², ¹The Ohio State University, ²South Dakota State University.

Effects of the calpain system on growth and IGF-I concentration were examined in 233 purebred Angus calf divergently selected for blood serum IGF-I concentration at the EORDC (Eastern Ohio Resource Development Center). Genotyping was performed by PCR-SSCP (single strand conformation polymorphism) and RFLP analysis at the calpain and calpastatin loci. The PCR primers were selected from the calpain II

regulatory subunit (CAPN4) and calpastatin domain I (CAST1). The IGF-I concentration on d 28 (IGF28), 42 (IGF42), and 56 (IGF56) of the 140-d postweaning test was measured. Birth weight (BW), weaning weight (WW), on-test weight (ONW), weight on d 28 (W28), 42 (W42), and 56 (W56) of the postweaning test, and off-test weight (OFW) also were measured. The activity of calpastatin (CAC), pH, myofibril fragmentation index (MFI) and Warner-Bratzler Shear Force (WBS) were measured on 47 bulls 13 to 15 mo of age. Fixed effects in this analysis were genotypes, year, season, IGF-I selection line, sex of calf, age of dam, and a covariate for age of calf. Genetic polymorphisms among individuals were observed for both loci (AA, AB, and BB). Differences in CAPN4 genotypes were found ($P=.01$) for WW, and CAST1 genotypes influenced W28 ($P=.09$), W42 ($P=.05$), W56 ($P=.03$), and IGF56 ($P=.06$). The pH was negatively correlated with WW ($r=-.28$, $P=.06$), W28 ($r=-.26$, $P=.08$), W42 ($r=-.24$, $P=.11$) and W56 ($r=-.25$, $P=.09$). Negative correlations of calpastatin activity with WW ($r=-.29$, $P=.05$), W28 ($r=-.28$, $P=.05$), W42 ($r=-.31$, $P=.03$), W56 ($r=-.32$, $P=.03$), and ADG ($r=-.31$, $P=.04$) were estimated, but no significant correlation between calpastatin activity and IGF-I concentration was observed for 47 bulls. Most measures of IGF-I concentration were highly positively correlated with weight traits. The WBS was generally negatively correlated with weight traits and IGF-I concentration, but MFI was not correlated with any of traits measured. Genetic variants discovered in this study may provide useful information for future selection programs.

Key Words: Calpain, IGF-I, PCR-SSCP

14 Peroxisome Proliferator-Activated Receptor γ ($PPAR\gamma$): a candidate gene for performance, carcass and muscle quality in swine. R. S. Emnett^{*1}, E. Grindflek², M. F. Rothschild³, S. J. Moeller¹, D. L. Meeker¹, K. M. Irvin¹, and R. N. Goodwin⁴, ¹The Ohio State University, ²Agricultural University of Norway, ³Iowa State University, ⁴National Pork Producers Council.

Currently the improvement of meat quality is one of the top priorities of the swine industry. Several environmental and genetic factors contribute to the ultimate quality of both fresh and processed pork. Peroxisome Proliferator-Activated Receptor γ ($PPAR\gamma$) is a transcription factor involved in regulating expression of genes associated with lipid metabolism. Previous results show $PPAR\gamma$ involvement in adipocyte differentiation in several species and therefore it may be associated with intramuscular fat. However, the effects of this gene on meat quality in the pig have yet to be determined. The objective of this study was to investigate the effects of $PPAR\gamma$ in four breeds of swine. Berkshire ($n=160$), Hampshire ($n=142$), Duroc ($n=74$) and Landrace ($n=54$) pigs, that had been highly characterized for growth, carcass and muscle quality traits were genotyped based on PCR-RFLP procedures. Statistical analysis was completed for the entire population ($n=430$) and for each breed separately using the GLM procedure in SAS with fixed effects of sire, sex, genotype and off test date. Total population analysis revealed effects ($p<.05$) of $PPAR\gamma$ on cooking loss, Instron tenderness and juiciness score. Individual breed analysis also indicated significant $PPAR\gamma$ effects on Instron tenderness (Landrace), backfat (Duroc and Landrace), cooking loss (Hampshire), flavor score (Berkshire) and average daily gain (Hampshire and Landrace). Allelic frequencies were similar among all breeds except Berkshire. These results warrant larger scale investigation to determine the potential use of $PPAR\gamma$ in selection for meat quality traits and growth in swine.

Key Words: Swine, Meat Quality, Candidate Gene

15 Genetic variation of Wood's lactation curves in dairy sheep: a Bayesian approach. Yu-Mei Chang^{*1}, Romdhane Rekaya², Daniel Gianola¹, and David L. Thomas¹, ¹Department of Animal Sciences, University of Wisconsin-Madison, ²Department of Dairy Science, University of Wisconsin-Madison.

Test-day milk yield records (1752) of 451 first-lactation ewes in 4 flocks from Nebraska and Wisconsin were analyzed. Breeds included crosses among Dorset, Romanov, Targhee, Rideau Arcott, Polypay, Suffolk, Rambouillet, Finnsheep and East Friesian. The objective was to investigate genetic variation of features of lactation curves using a 3-stage Bayesian hierarchy. Wood's model, $E(y)=at^b \exp(-ct)$, was used as first-stage; a indicates level of starting yield, and parameters b and c describe ascending and descending phases of the lactation curve. The second

stage described variation between ewes. It had a linear structure including flock-year, age at lambing, type of lambing, length of suckling period and the expected percentage of genes of East Friesian origin as fixed effects, plus random additive genetic effects. The third stage included prior distributions for all unknown parameters. Gibbs sampling and the Metropolis-Hastings (MH) algorithm were employed for drawing samples from posterior distributions of a , b and c . A chain of 60,000 iterations (burn-in of 11,000) was used. Acceptance rate with MH was 24%. Residual variance (posterior mean) was 0.042 kg^2 . Heritabilities and genetic correlations were from embedding a Bayesian mixed model analysis within the hierarchy. Posterior means of heritability of a , b and c were 0.35, 0.35 and 0.27, respectively. Estimates indicate that part of the variation in lactation curves between ewes is heritable. Genetic correlations were negligible, suggesting flexible scope for modifying lactation curves via genetic selection. About 0.4% of the test-days records were declared outliers, indicating a reasonable fit.

Key Words: Lactation curves, Non-linear mixed effects model, Bayesian analysis

17 Inbreeding in swine seedstock herds. T.A. Rathje*, Danbred USA, L.L.C., Seward, NE, USA.

Modern swine breeding is undergoing a series of changes that affect the underlying strategies for genetic improvement. Genomics technology is leading to the understanding of genetic variation on a molecular level that will eventually supplement the methodologies breeders currently utilize to produce desirable changes in allele frequency. Within the context of inbreeding, identification of deleterious alleles for fitness traits would permit breeders to avoid the random perpetuation of these characteristics within small, closed nucleus herds undergoing intense selection for economically important traits. The current situation is, however, more traditional and involves the implementation of relatively simple strategies to delay the accumulation of inbreeding within nucleus populations. The methods often include arbitrary restrictions on the percentage of sows mated to a single sire, the number of sires retained from a full and half-sib family, the avoidance of matings between closely related individuals and elimination of families presumed to be segregating for alleles with deleterious effects on fitness. Classic genetic theory applies wherein inbreeding is delayed, but is inevitably accumulating within nucleus herds. Composite lines addressing specific market needs, particularly for terminal sires, offer short-term solutions for nucleus level inbreeding. Most parent and terminal products are produced from line crosses wherein inbreeding is eliminated in the resulting progeny. Understanding the causes of inbreeding depression continues to be important in order to improve the performance of purelines in multiplication, leading to more efficient transfer of genetic improvement.

Key Words: Inbreeding, Swine, Genetic improvement

18 The interaction of selection intensity, inbreeding depression, and random genetic drift on short and long term response to selection: results from biological and finite locus simulations models. W.M. Muir*, Purdue University.

Egg production, a heterotic trait in poultry, is strongly affected by inbreeding depression. Experimental evidence indicates a combination of dominance and epistatic gene effects are involved. The impact of selection intensity and population size on short and long term response to selection for heterotic and non-heterotic traits was examined using a gene level simulation program that assumed a finite number of loci and a finite population size. Results showed that the optimal selection intensity was always less for heterotic than non-heterotic traits. However, for both types of traits, attention must be given to the rate of inbreeding because inbreeding also reduces long term response to selection as a result of random genetic drift. Use of a subdivide-merge scheme to control the rate of inbreeding was examined using a biological simulation with *Tribolium Castaneum*. Results indicated that this method was ineffective in controlling inbreeding compared to a single large population with the same overall effective population size. However, comparison of the rate of inbreeding depression in the control and selected lines showed marked contrasts in the predominant forms of gene action. The control line exhibited simple linear depression (indicative of directional dominance) while in both selected lines the depression was quadratic (indicative of epistasis), but in opposite directions. The implication is that adjustment for inbreeding depression may require a quadratic term,

the sign for which could be positive or negative depending on the type of epistasis selected for. These results also demonstrate that epistatic gene action can be an important factor in inbreeding depression yet not be detectable in the base population.

Key Words: Inbreeding Depression, Epistasis, Random Genetic Drift

19 Studies on the effects of dominance and inbreeding in genetic evaluations of dairy cattle, beef cattle, and swine. I Misztal^{*1}, J. K. Bertrand¹, M. Duangjinda¹, and T. Druet², ¹University of Georgia, Athens 30602, ²Facult Universitaire des Sciences Agronomiques, B-5030 Gembloux, Belgium.

Potential gains from including the dominance and the inbreeding effects in genetic evaluations include improved prediction of additive values and availability of specific combining abilities for each pair of prospective parents. The magnitude of such gains depends on the magnitude of the dominance variance and the value of the inbreeding depression. Accurate estimates of the dominance variance require large data sets, particularly for cattle where the fraction of animals with dominance relationships is low. In single-trait models, Method R can be used for variance component estimation for complete populations, but it becomes unreliable for models with covariances. Software is available to estimate these variances using REML and MCMC methodology using smaller data sets. Estimates of dominance variance for dairy and beef cattle and for swine obtained with large data sets and Method R were up to 10% of phenotypic variance. As a percentage of additive variance, the estimate of dominance variance reached 78% for 21-day litter weight of swine and 47% for postweaning gain of beef cattle. Changes in additive evaluations after considering dominance were largest for dams from a single large full-sib family. Changes were found to be important for dairy cattle especially for dams of ET animals, but less important for swine. Recent analyses of beef cattle data used a model with both direct and maternal inbreeding, additive and dominance effects. For weaning weight, REML estimates of the dominance direct and maternal variance were 7.2% and 1.3% of the total variance, and the correlation between the two effects was -0.46. Estimates of inbreeding depression in units of kg/1% of inbreeding were -.20 for direct and -0.025 for maternal. Further studies will consider multi-trait analyses and nonlinear inbreeding depression separate for sexes.

Key Words: Dominance, Inbreeding, Genetic evaluation

20 Models for estimating the genetic correlation between direct and maternal effects. L. D. Van Vleck^{*1} and M. D. MacNeil², ¹USDA, ARS, US Meat Animal Research Center, Lincoln, NE, ²USDA, ARS, Livestock & Range Research Laboratory, Miles City, MT.

A large negative genetic correlation between direct and maternal effects (r-am) is often reported for weaning weight of beef cattle. Weaning weights of 3854 calves of the Ft. Keogh Line 1 Herefords were analyzed to determine the consequences of adding to the usual direct-maternal genetic model (AM), effects due to sire by year interaction (S), grand-maternal genetic effects (G), and regressions (R) on calendar birth day of the dam and birth, weaning and yearling weights of the dam. Fixed factors in all models were year-sex and age of dam with linear covariates for calendar birth day of the calf with the weaning weight and inbreeding coefficients of calf and dam. Permanent environmental effects of dam and granddam as appropriate were in models with M and G. Julian birth day of dam was significant but did not affect estimates of genetic parameters. Birth and yearling weights of dam were not significant. Weaning weight of dam was significant and did affect estimates of genetic parameters, primarily increasing r-am from -.39 to -.04 for AM and from -.16 to .03 for AMG. The AMG model increased maternal heritability from .16 to .41 and r-am from -.37 to -.16. Effect of G (R) depended on whether R (G) was also in model. Addition of sire by year interaction slightly reduced direct heritability and slightly increased r-am by .08 for AM and .05 for AMG. Effect of S on r-am was similar for all models. Likelihoods for models with S and G were significantly better than for models without S and G. The AMG models introduced a large negative genetic correlation between maternal and grandmaternal effects (-.82 to -.89). Effects of R were larger than effects of G and S on r-am although

G increased the likelihood the most. These results indicate that modeling maternal genetic effects for genetic evaluation is a complex and unsolved problem.

Key Words: Genetic Evaluation, Genetic Parameters, Beef Cattle

21 Genetic analysis of mature cow weight of crossbred beef cattle. J. Arango^{*1}, L. V. Cundiff², and L. D. Van Vleck³, ¹University of Nebraska, Lincoln, NE, ^{2,3}USDA, ARS, US Meat Animal Research Center, ²Clay Center, NE, ³Lincoln, NE.

Data from the first four cycles (phase two) of the Germplasm Evaluation Program (MARC-USDA) were used to evaluate mature weight of F1 cows produced by crosses of 22 sire and two dam (Angus and Hereford) breeds. Weights were available from two through eight yr of age. Cow weights (cw) (n=61789) and cow weights adjusted for condition score (cwa) were analyzed by REML. Different models were tested to evaluate sets of fixed effects and random effects. The final model included cow line, age in years, season of measurement (1 to 4) and their interactions, year of birth and pregnancy-lactation code as fixed effects. Random effects included direct additive genetic and permanent environmental effects of the cow. Genetic maternal effects were found to be negligible and then excluded from the model. Univariate analyses of all data, by season and by age in years, and bivariate analyses between pairs of seasons and ages (2 to 6) were performed. Analyses by age included age in days within seasons as additional covariates. Heritability estimates over all ages were $.49 \pm .04$ and $.54 \pm .04$ for cw and cwa. Heritability estimates ranged from .47 to .58 for cw by age and from .49 to .61 for cw by season. Permanent environmental variances were about one third of those for genetic effects, except for older cows and for season four for cw. Bivariate analyses were slow to converge due to boundary conditions. Estimates of genetic and permanent environmental correlations converged to one for all season combinations for cw. Estimates of genetic correlations were over .92 for all age combinations while those for permanent environmental effects ranged from .56 to 1.00, being smaller between extreme ages, for cw. Results for cwa were similar, with relatively higher heritabilities and smaller permanent environmental variances. Results suggest that cw is basically the same trait for all seasons within a year, as well as for all ages. A repeatability model seems to suffice to model cow weight in this population.

Key Words: Heritability, Genetic Correlations

22 Genetic parameters for cow weights at different ages. J. M. Rumph^{*1}, R. M. Koch¹, K. E. Gregory², L. V. Cundiff², and L. D. Van Vleck^{2,3}, ¹University of Nebraska, Lincoln, NE, ^{2,3}US Meat Animal Research Center, ²Clay Center, NE, ³Lincoln, NE.

Data were 14,419 weight records of Hereford cows taken from 1 to 8 years of age. The cows represented a control line and three selection lines selected for weaning weight, yearling weight, and an index of yearling weight and muscle score. Each record included a measurement of cow weight at the time of brand clipping (BC) and/or just before breeding (BB). Records also included age of dam (AD), year (Yr), age (Ag), line (Ln), pregnancy status (Pg), birth and method of rearing (BMR), and calf disposal code (DSP). Fixed effects in the model were AD and Yr x Ag x Ln, Pg x Ln, BMR x Ln, and DSP x Ln subclass effects. Random effects included in the model were direct genetic, direct permanent environment, uncorrelated dam maternal, and residual. The interval between calving and weigh date was included as a covariate. Estimates of genetic parameters were obtained using a REML algorithm. For BC and BB weights, estimates over all ages of fractions of variance (and SE) were .67 (.03) and .63 (.03) for direct genetic, .00 (.03) and .00 (.02) for direct permanent environment, and .07 (.02) and .11 (.01) for dam maternal effects. For BC weights (no yearling data included) with bivariate analyses at different ages, estimates of direct heritability ranged from .42 to .72, genetic correlations between ages ranged from .86 to 1.00, and correlations between maternal effects of dams ranged from .00 to .05. For BB weights, direct heritability ranged from .21 to .36 for yearling weights and .47 to .71 for older weights, genetic correlations between ages ranged from .79 to 1.00, and correlations between maternal effects of dams ranged from .00 to .09. Genetic correlations with weights at older ages increased from yearling weights to weights at three years of age and then were near unity for weights taken at four years and older. These results indicate that measurements of cow weights at two to four years of age could be used to select for desired mature weight.

Key Words: Heritability, Mature Weight, Beef Cattle

25 Bayesian inference on genetic parameters of calving difficulty in Italian Piedmontese cattle. K. Kizilkaya* and R. J. Tempelman, *Michigan State University, East Lansing, MI.*

Inferences on genetic (co)variance parameters for first parity calving ease in Italian Piedmontese cattle were obtained by analytically approximate and exact Bayesian methods. A total of 36,048 records based on a 5-level ordinal categorical scale were used in the study. A threshold sire and maternal grandsire mixed model utilizing identified paternal relationships was used. Other model factors included fixed age-sex effects and random herd year season (HYS) effects. Using Laplace's method, variance parameter estimates, expressed as a ratio of the total variance on the latent variable scale, were .25 for additive genetic heritability, .17 for direct maternal heritability, and .19 for HYS, while the direct-maternal genetic correlation was estimated to be -0.84. Marginal likelihood ratio tests indicated all sources of variability to be statistically significant. However, in spite of the large magnitude, the genetic correlation was not statistically significant. These inferences are further compared to estimates based on the approximate expectation-maximization method and to inferences based on Markov Chain Monte Carlo (MCMC) methods.

Key Words: Threshold model, Laplace's method, MCMC

26 Selection for lean growth rate in a synthetic line of Yorkshire-Meishan pigs 2. Correlated responses in litter traits. P. Chen*, T. J. Baas, and J. C. M. Dekkers, *Iowa State University.*

Correlated responses in litter traits in a synthetic line of Yorkshire-Meishan pigs selected for lean growth rate (LGR) along with randomly a selected control line were studied in 133 litters and 1057 pigs. Litter traits studied included: total number born (TNB); number born alive (NBA); number at 21d (N21) and 42d (N42); litter weight at birth (LBWT), 21d (L21WT), and 42d (L42WT); and piglet weight at birth (PBWT), 21d (P21WT), and 42d (P42WT). Correlated responses were estimated by two methods: deviation of the selected line from the control line (method 1) and multiple trait derivative free restricted maximum likelihood (method 2). Generally, estimates from the two methods were similar but tended to be more precise for the latter. Correlated responses based on the two methods were regressed on generation and the cumulative selection differential. In method 1, these regression coefficients were negative but not significant ($P > .05$) for TNB, NBA, N21, and N42. Statistically significant correlated responses occurred in L42WT and P21WT ($P < .05$). In method 2, a statistically significant correlated response occurred only in P42WT. The regression coefficients were negative but not significant for NBA, N21, and N42 for method 2. Coefficients were positive but not significant ($P > .05$) for PBWT, P42WT, LBWT, L21WT, and L42WT for method 2. Selection for LGR should have little effect on litter traits.

Key Words: Pigs, Selection responses, Lean growth rate

27 Frequency of the Rendement Napole (rn) gene in Hampshire swine. S.J. Moeller*¹, T.J. Baas², R.S. Emnett¹, D.L. Meeker¹, and K.M. Irvin¹, ¹*The Ohio State University, Columbus, OH*, ²*Iowa State University, Ames, IA.*

Progeny (N=116) from 14 purebred Hampshire sires nominated by seed-stock producers were used to test the prevalence of the Rendement Napole (RN) gene in a selected Hampshire population. This experiment was carried out at Iowa State University where dams and progeny were housed and reared. Live, press-biopsy samples of longissimus (L) muscle from 72 Yorkshire x Landrace females were subjected to Glycolytic Potential (GP) determination at market weight to verify rn+/rn+ genotype status. Females with GP values of $< 211.7 \mu\text{mole}$ lactate equivalent per gram tissue were used for mating. Mean, standard deviation and range of GP values for dams used in the study (N=32) were 160.6, 20.2, and 128.1 - 211.7 $\mu\text{mole/gram}$, respectively. A total of 32 litters, representing 1 to 3 litters and 5 to 24 pigs per sire were produced, from which 116 progeny were selected randomly within litter across sires for use in classifying RN genotype of the sire. Progeny genotype (RN-/rn+ or rn+/rn+) was established using the bimodal distribution of GP from the L muscle obtained post-mortem at 48 h. Mean, standard deviation, and range of progeny GP values were 132.7, 30.7, and 70.0 - 193.0 $\mu\text{mole/gram}$, respectively. The bimodal distribution threshold used for GP classification was: $\text{GP} \geq 150 \mu\text{mole/gram}$, RN-/rn+ (N=39), and

$\text{GP} < 150 \mu\text{mole/gram}$, rn+/rn+ (N=77). Sire RN status was determined through GP results of the progeny, assuming dams were rn+/rn+ and progeny genotypes represented the presence/absence of the dominant RN- gene in the sire. Sires were genotyped as RN-/RN- when the probability of detecting an rn+ allele from the sire was < 0.04 , RN-/rn+ when progeny expressed both the RN-/rn+ and rn+/rn+ genotypes, and rn+/rn+ when six or more rn+/rn+ progeny were detected. Results indicated one RN-/RN-, ten RN-/rn+, and three rn+/rn+ sire genotypes were found. The estimated gene frequency for the dominant RN- allele from this population was .43, which is lower than previous estimates in Hampshire populations. These results show that selection programs should be successful in identifying and selecting for or against alleles of the RN gene.

Key Words: Swine, Genotypes

28 Analysis of length of productive life and of lifetime prolificacy in Landrace sows using survival models. S Guo*¹, D Gianola¹, and T Short², ¹*University of Wisconsin-Madison*, ²*PIC USA.*

Factors affecting length of productive life (LPL) and lifetime prolificacy (LTP) in Landrace sows were investigated. Data were from 2616 daughters of 343 sires born in a Landrace nucleus herd. LPL was number of days between a sow's herd entry date and time of culling. LTP was total number of pigs born alive during the sow's career. Records from sows sold to farms for production purposes were censored. Factors were: year-season of entry into breeding herd, parity, age at herd entry, litter size at first parity (for LPL), and sire of the sow. About 16% of the records were censored. Two additional, random, censoring rates of 25% and 35% were created to assess influence of censoring on fixed effects, variance components and sire evaluations. Exponential and Weibull's hazard models were used to analyze records; the latter had a better fit. Heritabilities in a logarithmic scale were 0.16-0.38 for LPL and 0.13-0.23 for LTP, taking censoring into account. Sows entering the herd older and having a smaller number of pigs born alive in the first litter had a higher risk of culling. Age at herd entry did not affect LTP. Year-season affected LPL and LTP significantly. Estimates of sire effects with censored records removed from the analysis were in less agreement with evaluations obtained with the actual data set than those found with the artificial censoring rates. Information on censored records is relevant, as distinct survival curves are obtained when these are excluded.

Key Words: Herd-life, Prolificacy, Survival-models

29 Correlated responses in litter and growth traits to 2-stage selection for ovulation rate and litter size in swine. A. Ruz-Flores*, J. P. Cassady, and R. K. Johnson, *Department of Animal Science, University of Nebraska-Lincoln.*

The objectives were to estimate genetic parameters for litter and growth traits, and to quantify their correlated responses to selection for ovulation rate (OR) and litter size (LS). Lines were IOL derived from a line previously selected for OR and embryonic survival, and COL derived from the control line. Line C was a randomly selected control. Lines IOL and COL underwent 8 generations of 2-stage selection. In stage 1, all gilts from the 50% of the litters with greatest LS were retained. Of these gilts, approximately 50% were selected for OR in stage 2. Gilts selected were mated to boars selected from the upper one third of the litters for LS. The MTDFREML program with an animal model including the effects of animal, maternal, common litter of birth, generation, and sex was used to estimate correlated responses in 9 traits. Direct heritability estimates were from .15 to .20 for litter weaning weight, number of pigs weaned (NW), prenatal loss (PL), and individual weaning weight (IWW). Maternal heritability ranged from .04 to .25 for birth weight (BW), litter birth weight (LBW), 125-d wt (W125), and IWW. Estimates of direct heritability were from .25 to .40 for LBW, and W125. Estimates of direct heritability were from .40 to .73 for age at puberty (AP), backfat (BF), birth weight (BW), and 178-d wt (W178). Significant regression estimates of correlated responses per generation to 2-stage selection were decreased AP (-2.37.70, -2.03.67 d), and increased BW (.011.003, .006.002 kg), LBW (.36.07, .19.06 kg), PL (.15.05, .18.05 ova), in lines IOL and COL. Other significant correlated responses were increased W125 (.54.20 kg), and W178 (1.12.24 kg) in line IOL; increased BF (.30.07 mm), and NW (.15.03 pigs) in line COL. Correlated responses to selection for OR and LS were decreased age at

puberty, greater prenatal loss of embryos and increased birth weight in both lines. Responses in growth and backfat were inconsistent in the two selection lines.

Key Words: Correlated Responses, Litter Size, Ovulation rate

30 Genetic parameters of pork longissimus dorsi quality. R. N. Goodwin*¹, P. J. Berger², and T. J. Baas², ¹National Pork Producers Council, Des Moines, IA, ²Iowa State University, Ames, IA.

Genetic parameters of heritability, breed differences, and sex differences were estimated for pork longissimus dorsi quality traits. Barrows (2234) and gilts (1671) of eight breeds (Berkshire, 619; Chester White, 316; Duroc, 676; Hampshire, 465; Landrace, 478; Poland China, 283; Spot, 280; and Yorkshire, 788) were slaughtered and measured in the 1991-1999 National Barrow Show Progeny Tests. Each sire group represented three litters and had 3-9 pigs measured. There were 532 sire groups represented. The loin quality traits of NPPC color score (PC), NPPC marbling score (PM), NPPC firmness score (PF), Minolta reflectance (MINOLTAP), ultimate pH (PH), and Hunter color score (HUNTERP) were evaluated with a mixed linear model. The model fixed effects were slaughter date, breed, sex, and breed by sex interaction. The model random effects were sire nested in breed and dam nested in breed. Large breed, sex, and breed by sex differences were found for all traits. Heritabilities were estimated by dividing four times the sire variance by the total variance. Variance components were estimated by a REML algorithm. Heritabilities were: MINOLTAP, .49; HUNTERP, .44; PH, .53; PC, .45; PM, .59; and PF, .37.

Key Words: Pigs, Meat quality

ENVIRONMENT AND LIVESTOCK PRODUCTION

32 Lean and carcass characteristics of pigs in deep-bedded hoop structures and confinement buildings during summer and winter. A. D. Penner*, M. E. Larson, and M. S. Honeyman, Iowa State University.

Carcass characteristics of pigs reared in deep-bedded (cornstalks) hoop structures (HOOP) and a mechanically ventilated confinement building (CONF) were compared for a summer (Jun-Nov 1998) and winter trial (Nov-May 1999) in central Iowa. Three HOOP and six CONF pens were used. Barrows and gilts were fed five *ad libitum* corn-soy diets in phase. Each trial had 451 HOOP pigs and 132 CONF pigs, weighing 15 kg each. At first marketing, all pigs were scanned for tenth-rib backfat (BF) and loin muscle area (LMA) with real-time ultrasound. Pigs (109 kg or more) were marketed. Remaining pigs were returned to their respective pens until reaching an average of 105 kg. Lean percentage with 5% fat (% LEAN), lean gain on test (LGOT), and efficiency of lean gain (ELG) was calculated using the BF and LMA scan values. For the summer trial, at scanning, HOOP pigs weighed 112 kg at 113 d and CONF pigs weighed 115 kg at 118 d on feed. HOOP pigs had more BF (24.6 vs 21.6 mm; $P < .05$), less LMA (38.1 vs 41.4 cm²; $P < .001$), and less % LEAN (50.2 vs 52.2%; $P < .001$) than CONF pigs. There was no difference for LGOT (322 vs 331 g lean/d) or ELG (138 vs 135 g lean gain/kg feed). In the winter trial, at scanning, HOOP pigs weighed 106 kg at 132 d and CONF pigs weighed 108 kg at 125 d on feed. HOOP pigs had similar BF (19.5 vs 19.6 mm), less LMA (38.7 vs 42.3 cm²; $P < .01$), less % LEAN (53.1 vs 54.3%; $P < .05$), and slower LGOT (281 vs 308 g lean/d; $P < .01$) and poorer ELG (134 vs 164 g lean gain/kg feed; $P < .01$) than CONF pigs. Yield for summer trial was 73.8 and 75.1%, and for winter trial was 75.3 and 76.3%, for HOOP and CONF pigs, respectively. Pigs trimmed at plant from summer trial was 4.3 and 7.2%, and from winter trial was 3.8 and 6.2%, for HOOP and CONF pigs, respectively. Pigs fed in hoop structures had the same or more BF, smaller LMA and less % LEAN than pigs fed in confinement. Yield and percentage of pigs trimmed at plant was less for pigs fed in hoops compared to confinement.

Key Words: Swine management, Bedded hoop structures, Lean growth

31 Genetic parameter estimates for prolificacy, growth and fleece characteristics in Polypay sheep. K. J. Hanford*¹, L. D. Van Vleck², and G. D. Snowder³, ¹University of Nebraska, Lincoln, ²USDA, ARS, US Meat Animal Research Center, Lincoln, NE, ³USDA, ARS, US Sheep Experimental Station, Dubois, ID.

Heritabilities and genetic correlations for prolificacy, growth and fleece traits were calculated from Polypay data collected from 1977 to 1998. Number of records ranged from 8,313 to 9,081, 11,104 to 11,896, 1,805 to 8,872 for prolificacy, growth and fleece traits. Direct heritability estimates from single trait animal model analyses using REML were .11 for number lambs born (NB), .02 for number lambs weaned (NW), .05 for litter wt at weaning (LW); .17 for birth wt (BW), .18 for 120 day wt (WW), .68 for fleece grade (FG), .36 for fleece wt (FW) and .76 for staple length (SL). Maternal heritability estimates were .20 for BW and .07 for WW. Estimates of genetic correlations between prolificacy traits were positive (.40 for NB-NW, .19 for NB-LW, .91 for NW-LW). Between BW and WW both the direct and maternal correlations were positive (.57 for direct and .48 for maternal). FG was negatively correlated with both FW (-.37) and SL (-.70), and FW was positively correlated with SL (.65). Estimates of genetic correlations were low between the growth traits and NB and NW (.10, .24, .00, .07 for NB-BW, NB-WW, NW-BW, and NW-WW), and moderate between the growth traits and LW (.35 with BW and .74 with WW). FW was negatively correlated with NB (-.26) and NW (-.05), and was positively correlated with LW (.19). FG was positively correlated with the prolificacy traits (.09, .34, .04 for NB, NW, and LW), and SL was negatively correlated with the prolificacy traits (-.05, -.35, -.17 for NB, NW, and LW). Growth and fleece traits were positively correlated, except for the correlation between BW and FG, which was negatively correlated (.54, -.03, .17, .18, .03, .02 for BW-FW, BW-FG, BW-SL, WW-FW, WW-FG, and WW-SL).

Key Words: Heritabilities, Genetic Correlations

33 Performance of finishing pigs in deep-bedded hoop structures and confinement during summer and winter. M. E. Larson*, M. S. Honeyman, and A. D. Penner, Iowa State University.

The performance of finishing pigs in deep-bedded hoop structures (HOOP) and a mechanically ventilated confinement building (CONF) was compared during a summer trial (Jun-Nov 1998) and a winter trial (Nov-May 1999) in central Iowa. Three hoop and six confinement pens were used. Large round bales of cornstalks were used for bedding in the hoops. A mix of barrows and gilts (about 15 kg) were fed five *ad libitum* corn and soybean meal-based diets in phase. For each trial there were 451 HOOP pigs and 132 CONF pigs. HOOP pigs were allowed 1.11m²/pig and CONF pigs were given .74m²/pig according to industry standards. All pigs were weighed at 28 d intervals until the pen averaged 109 kg and marketing began. Marketing occurred on two dates for each housing system. For the summer trial, average feed intake (disappearance) was similar (2.40 vs 2.44 kg/d). The HOOP pigs grew faster (867 vs 826 g/d; $P < .001$) than the CONF pigs. HOOP pigs reached market weight sooner (117 vs 122 d) and were more efficient (358 vs 338 g gain/kg of feed; $P < .01$) compared to the CONF pigs. Mortality rate was lower for the HOOP pigs (2.0 vs 4.5%). Bedding used was 88.4 kg/pig. The summer trial average market weight was 118 kg with only one light pig (<100 kg). For the winter trial, the HOOP pigs ate more feed (2.35 vs 2.24 kg/d; $P < .05$), grew slower (713 vs 745 g/d; $P < .01$) and were less efficient (302 vs 335 g gain/kg of feed; $P < .01$) than the CONF pigs. HOOP pigs took longer to reach market weight (148 vs 136 d). There were more HOOP light pigs (<100 kg) at market (3.5 vs 2.3%) than in CONF. Mortality rate was higher for the HOOP pigs (5.5 vs 2.3%) than in CONF. Bedding use was 100 kg/pig. The winter trial average market weight was 119 kg for HOOP pigs and 116 kg for CONF pigs. Overall, finishing pigs in hoop structures in Iowa were seasonally affected, with pig performance better than confinement in the summer and poorer than confinement in the winter.

Key Words: Pigs, Bedded hoop structures, Growth

34 The effect of removal of pigs from a group on growth performance and feed intake behavior of market weight pigs. N.R. Augspurger*, M. Ellis, and J.L. Beverly, *University of Illinois*.

The objective of this study was to evaluate the effect of removal of pigs from a group on growth performance and feeding behavior. A total of 192 pigs were used in a CRD with a 2x2x3 factorial arrangement of treatments (feeder type [conventional and FIRE system]; sex [castrate and gilt]; and group size/removal [6 pigs with none removed (6/6); 9 pigs with none removed (9/9); 9 pigs with 3 pigs removed (9/6)]). Pigs were on test for 4 wk between live weights of 100.6±10.2 and 127.2±12.9 kg. The three heaviest pigs in 9/6 at the end of wk 2 were removed. Feeding behavior was monitored using an automated feed intake recording system (FIRE). Pigs were allowed a 12-d acclimation period before initiation of the trial. Pigs on conventional feeders had higher overall (wk 1 to 4) feed intakes ($P < .05$), similar growth rates, but lower gain:feed ratios ($P < .01$) compared to pigs on the FIRE system. Castrates consumed more feed ($P < .001$) and grew faster ($P < .05$) than gilts over the 4-wk period. Group size/removal treatment had no effect on growth performance. Castrates spent more time feeding per day than gilts in period 2 (wk 3 to 4) (88.4 vs. 75.8 min, respectively; $P < .01$) and overall (87.7 vs. 78.0 min, respectively; $P < .05$). Sex did not affect other feed intake traits. In period 1 (wk 1 to 2), 6/6 visited the feeder more often ($P < .05$), spent more time at the feeder per visit ($P < .01$), and per day ($P < .05$) than 9/9 and 9/6. In period 2, 6/6 and 9/6 visited the feeder more often per day ($P < .001$) than 9/9, but consumed less per visit ($P < .001$). 9/6 had the highest feeder occupation time per day ($P < .05$), and the lowest feed consumption rate ($P < .05$) in period 2. In 9/6, removal increased number of visits per day from 9.7 and 10.4 in wk 1 and 2, respectively, to 13.7 in each of wk 3 and 4 ($P < .01$). Removal of pigs in 9/6 also decreased feed intake per visit from 277.0 and 282.0 g in wk 1 and 2, respectively, to 233.2 and 247.9 g in wk 3 and 4, respectively, ($P < .05$). This indicates that removal of pigs may change the feeding behavior of pigs due to the lower group size.

Key Words: Pigs, Feeding Patterns, Management

35 The effect of group size on the variation in feed intake monitored using an electronic feeding systems. Young Hyun* and Mike Ellis, *University of Illinois*.

The variation in daily feed intake and feeding patterns for pigs reared in groups of 2, 4, 8, and 12 pigs were compared for individuals within a group and for the group as a whole. Feed intake levels and patterns were monitored using electronic feed intake recording equipment (FIRE). The study used 208 commercial hybrid pigs (barrows and gilts) in 32 pens (8 pens per group size). Pigs were grown from 26.0 to 47.8 kg live weight over a 4-wk period. A corn-soybean meal diet (17.4% crude protein and 3,298 Kcal ME/kg) was available ad libitum. Feed intakes and growth rates declined linearly with increasing group size. Daily feed intake of pigs across all group sizes increased from 1.38 to 1.92 kg during the experimental period. There was substantial day to day fluctuation in feed intake with the coefficient of variation (CV) for feed intake per day over the 4-wk period measured on the data for individual pigs in groups of 2, 4, 8 and 12 being 18.6, 20.6, 19.6 and 22.5%, respectively. The CVs for feed intake per day measured on the group means over the 4-wk period were higher than for the individual pig data (22.3, 24.3, 24.6 and 25.7%, respectively). The increase in CVs with increasing group size is most likely due to greater competition at the feeder with larger groups. Average daily feed intakes (ADFI) of all pigs were 1.47, 1.59, 1.79, 1.98 kg in the first, second, third and fourth week of the study, respectively (CV: 21.9, 21.3, 22.7 and 22.7%, respectively). During each week, daily feed intake variations based on individual pig means were less variable (CV: 16.7, 17.0, 18.5 and 17.4%, respectively) than that based on the group means (CV: 20.9, 20.1, 21.4 and 22.0%, respectively). Data from this study suggest that the variation in daily feed intake increases with group size and is greater for data based on group means than for that based on individual pigs.

Key Words: Feed Intake, Group Size, Growing Pig

36 Effects of Yucca extract supplementation on performance and lung integrity of grower-finisher pigs. L. Van den Berghel¹, H.G. Schuerink², and K.A. Jacques*³, ¹*Agricultural College Ghent, Ghent, Belgium*, ²*Alltech Netherlands, Capelle aan den IJssel, The Netherlands*, ³*Alltech Inc., Nicholasville, KY, USA*.

Air quality is known to affect both animal performance and health. The objective of this study was to evaluate effects of a yucca extract product intended to reduce atmospheric ammonia on performance overall health in commercial pigs (25 to 110 kg) reared under Central European conditions. Pigs (Hypor Hybrid x Pietrain, n=416, initial weight 25 kg) were accommodated in one building comprised of four compartments each containing 8 pens of 13 pigs. All pigs received liquid feed (starter, grower, finisher) 3X daily with diets in two of the compartments containing 120 ppm yucca extract (De-Odorase, Alltech Inc.) based on 88% DM. House temperature was 24 C at the start of the grower phase and 20 C at the end of the fattening phase (110 kg). Pens had slatted floors and compartments had a ceiling ventilation system. Pig weights were recorded at the start and finish and feed intake was determined daily. Lung integrity was evaluated at the abattoir by a veterinarian. Results were subjected to ANOVA. Daily liveweight gain and feed conversion (FCR) were unaffected by treatment (daily gain, 687 vs 694 g; FCR, 2.50 vs 2.55 for control vs treated). The percentage of lean meat tended to improve in response to De-Odorase; as did the carcass quality classification score (lean meat, 56.5 vs 58.1%; carcass classification score (1=best, 14=worst) 8.55 vs 7.96 for control vs treated). Yucca extract addition to the diet had a beneficial impact on overall pig health as indicated by the number of pigs lost or culled and lung integrity at slaughter. There were fewer pigs lost in the treated group (2.41 vs 1.80%). Postmortem examination of the lungs revealed that 56% of pigs in the control group had normal lungs while 44% had inflamed lungs and 25% had pleuritis. In the group supplemented with De-Odorase, 90% had normal lungs while 9 and 3.2% were classified as having inflamed lungs or pleuritis, respectively (control vs treated, $p < .001$). It was concluded that yucca extract supplementation was associated with improved respiratory health as indicated by reduced incidence of abnormal lungs.

Key Words: Air quality, Yucca extract, Respiratory health

37 Impact of dietary distillers dried grains with solubles on performance, manure characteristics, and odor emissions of finishing pigs. A.K. Gralapp*, W.J. Powers, and D.S. Bundy, *Iowa State University, Ames, IA*.

Finishing pigs were fed distillers dried grains with solubles (DDGS) to evaluate the effects on pig performance, manure characteristics, and odor emissions. Three isocaloric, isonitrogenous diets containing 0, 5, or 10% DDGS were fed during six 4-wk feeding periods. Week 1 served as a diet adjustment period. Animals were housed in feeding rooms (6 pigs/room) with one treatment per room. Each room was equipped with a 2.4 m x 2.4 m pen, a self-feeder, a nipple waterer, and an individual manure pit. A new group of animals (average initial BW = 86 kg) was used for each feeding period. Diets were replicated four times. Pits were cleaned once weekly (d 7). Samples collected weekly on d 4 and 7 from each room were manure pit samples, air samples for electronic nose evaluation (1-L Tedlar bags), air samples for olfactometry analysis (10-L Tedlar bags), and air samples adsorbed onto solid phase microextraction fibers for gas chromatography-mass spectrometry analysis (GC-MS). No differences in animal performance ($P > .05$) or manure characteristics ($P > .10$) were observed. Increasing dietary content of DDGS increased odor intensity non-significantly ($P = .16$). Sixteen compounds, primarily non-sulfur protein metabolites, were quantified in room air samples by GC-MS. Using these compounds, an equation was generated to predict odor dilution threshold. Poor prediction capability ($R^2 = .23$) indicates that additional analytes require consideration, although repeated occurrence of other analytes in air samples was not evident from GC-MS analyses. Electronic nose evaluation of room air samples was not strongly correlated to olfactometry measures ($r = .18$). The equation developed from GC-MS analyses was capable of predicting the electronic nose response to air samples ($R^2 = .81$). Results suggest that human responses may be based on detection of compounds not included in GC-MS quantification procedures and not well detected by the electronic nose. Variation in response within and among panelists may account for some of the discrepancy between human assessment and chemical and instrumental methods of odor evaluation.

Keywords: Odor, Manure, Diet

Key Words: Odor, Manure, Diet

38 Development of an odor quantification model to correlate human odor response magnitudes to air concentrations of volatile organic compounds emitted from swine effluent. J.A. Zahn*, A.A. DiSpirito, Y.S. Do, D.W. Russel, and E.E. Cooper, *Iowa State University, Ames.*

Anaerobic storage of livestock waste results in the production of malodorous air pollutants including volatile organic compounds (VOCs), hydrogen sulfide, and ammonia. The quantification of odor and trace gases emitted from animal production facilities has traditionally been addressed in separate, unrelated research efforts. The current lack of information concerning the chemical identity of odorant compounds emitted from animal production facilities has impeded research efforts in the development of emission abatement strategies and has forced neighboring communities to rely on subjective olfactory measures for regulation of odor nuisance. In this study, direct measurements of malodorous VOCs present in ambient air samples from 29 swine production facilities were used to develop a 19 component VOC odorant standard that was observed to mimic olfactory properties of swine manure. A dynamic emission chamber was developed to deliver air samples containing the VOC standard to a nose cone. Simultaneous analyses employing either a human panel consisting of 12 subjects or a gas chromatograph were performed to assess human olfactory responses or odorant concentration, respectively. The ability of subjects to distinguish different air concentrations of the VOC standard was assessed by presenting six serial dilutions of the VOC standard to panelists. Fishers LSD statistic showed that the subjects were sensitive to changes in air concentration of the VOC standard across a range of serial dilutions differing by $\geq 14\%$. Chemical synergisms and antagonisms were identified by altering the concentration of individual components in the VOC standard over a 2-fold concentration range while maintaining the other 18 VOCs at a constant air concentration. Synergistic olfactory responses were observed to occur with acetic acid and 3-methyl indole (skatole), while an antagonistic olfactory response was observed with 4-methyl phenol (p-cresol). The collective odorant responses for swine waste VOCs were utilized to develop a prediction model to estimate human odor responses directly from air concentrations of "indicator" VOC odorants.

Key Words: Livestock Manure Management, Odor, Volatile Organic Compounds

39 Air pollution from swine production facilities differing in waste management practice. J.A. Zahn*^{1,2}, J.L. Hatfield², A.A. DiSpirito¹, and Y.S. Do¹, ¹*Iowa State University, Ames,* ²*National Soil Tilth Laboratory, USDA-ARS, Ames, IA.*

Gaseous emissions from swine manure storage systems represent a concern to air quality due to the potential impacts of hydrogen sulfide, ammonia, methane, and volatile organic compounds on environmental quality, human health, and wellbeing. The lack of knowledge concerning functional aspects of swine manure management systems has been a major obstacle in the development and optimization of emission abatement technologies for these point sources. In this study, a classification system based on emission characteristics and solution-phase concentrations of phosphorus (P) and sulfur (S) was devised and tested on 29 swine manure management systems in Iowa, Oklahoma, and North Carolina in an effort to elucidate functional characteristics of swine manure management systems. Four swine manure management system classes were identified that differed in solution-phase concentrations of P and S, methane emission rate, odor intensity, and air concentration of volatile organic compounds (VOCs). Odor intensity and the air concentration of VOCs emitted from swine manure management systems were shown to be strongly correlated ($r^2 = 0.88$). The concentration of VOC in air samples from the 29 swine manure management systems was highest with high-load, outdoor manure management systems (Type 2). These swine manure management systems were also observed to have the highest odor intensity levels. Volatile organic compound (VOC) emission rate and odor intensity for swine manure management systems were found to be inversely correlated with methane and ammonia emission rates. Emission rate of methane, ammonia, and volatile organic compounds were found to be dependent upon manure loading rate and indirectly influenced by animal numbers.

Key Words: Animal Manure Management, Volatile Organic Compounds, Odor

40 Effects of dietary manipulation on nutrient output in growing swine. J. L. Waggoner, L. T. Frobish, C. W. Wood, and W. F. Owsley*, *Auburn University.*

Six crossbred barrows (38.88 + 2.5 kg.) were used in a replicated 3 x 3 Latin square to investigate the effect of diet manipulation on nutrient output. Treatments were: A) a corn-soybean meal control diet, B) a triticale-soybean meal diet, or C) a triticale-amino acid (l-lysine, l-threonine, dl-methionine, and l-tryptophan) diet supplemented with soybean meal. All diets were formulated to be iso-lysine, iso-caloric, and iso-available phosphorus (.95%, 3.02 mcg/kg ME, and .23%, respectively). Pigs were randomly allotted to treatments and housed in stainless steel metabolism crates for the duration of the experiment. Each period consisted of five days adjustment followed by five days of total urine and fecal collection. Ferric oxide was used as a visible marker to indicate the beginning and end of each collection period. All samples were frozen immediately after collection to prevent nitrogen loss. The data were analyzed as a replicated Latin Square design ($\alpha = 0.20$). Means were separated using predetermined contrasts. Urinary excretion of nitrogen per unit of nitrogen intake was lower in pigs fed diet C (.21 mg/mg) than those fed diets A (.27 mg/mg) and B (.32 mg/mg), while pigs fed diet A (.27 mg/mg) excreted less urinary nitrogen per unit of nitrogen intake than those fed diet B (.32 mg/mg) ($P < .05$). Total nitrogen excretion per unit of nitrogen intake was lower in diets A and C than in diet B (.58, .64, and .72 mg/mg, respectively, $P < .05$). There were no differences in fecal nitrogen excreted per unit of nitrogen intake among treatments (.32, .39, and .43 mg/mg, respectively, $P > .20$). Additionally, there were no differences in total excretion of copper and zinc per unit of intake among treatments (.19, .23, and .24 mg/mg, and .19, .19, and .23 mg/mg, respectively, $P < .05$). These results indicate that manipulation of dietary ingredients can alter nitrogen excretion in growing swine.

Key Words: Pigs, Nitrogen, Excretion

41 Efficacy of wool-polyester blankets in improving weight gain and health of newborn beef calves in dry lot conditions. T. W. Loy*, J. W. Schroeder, G. P. Lardy, G. T. Wallace, and W. D. Slinger, *North Dakota State University, Fargo.*

Forty-eight cow-calf pairs (Angus x) were used to test the efficacy of wool/polyester blankets in improving weight gain and health status of newborn beef calves. Animals were fed the same diets and penned together in dry lots with barn access. Treatments included blanketed (B) and non-blanketed (N) calves. Blankets were placed on calves within twelve h post-partum. Birth weights were recorded and subsequent weights taken weekly following birth of the last calf. To test environmental differences attributable to differing birth dates a paired analysis was performed on the weight gain data. Calves from B were paired with an N counterpart with a similar birth date ($n = 24$). The first pair was born on January 6, the last on January 18, and the trial ended on February 26, 1999, allowing 4 periods. Weight gain data were analyzed as a split-plot in time, and the model included effects of treatment, period, pair, and the associated interactions. Calf morbidity and mortality were recorded and analyzed by chi-square analysis. No treatment x period interaction was detected ($P = .75$). However, because previous data indicated that the beneficial effects of the blankets have been greater in younger calves, we elected to show gain differences within period. Blanketed calves gained faster than N within each period ($P < .02$), but the improvement decreased from 7.7% in period 1 to 4.7% in period 4. Four B calves and one N calf were treated for sickness ($P = .16$). Pneumonia was the diagnosis in each case, and was more apparent in B once temperatures exceeded 0 C. Weather information, obtained from the North Dakota Automated Weather Network, is shown in the table. Blankets improved weight gain in newborn beef calves in dry lot conditions. This was especially true in the first 14 to 21 days after birth, and(or) when colder temperatures prevailed.

Period	ADG, kg				Temperature °C	
	B	N	SE	P	Avg High	Avg Low
1	1.12	1.04	.02	.008	-7.2	-16.7
2	1.22	1.14	.02	.001	-6	-10.0
3	1.14	1.08	.02	.02	-3.3	-12.2
4	1.12	1.07	.02	.02	1.1	-6.1

Key Words: Calves, Blankets, Health

42 An ecological study of the percentage of feedlot cattle shedding detectable *Escherichia coli* O157:H7 in the feces and potential relationships to characteristics of the pen. D.R. Smith*, M.P. Blackford, S.M. Younts, R.A. Moxley, J.T. Gray, L.L. Hungerford, C.T. Milton, and T.J. Klopfenstein, *University of Nebraska, Lincoln*.

The objective of this study was to describe feedlot pens by the point-prevalence of cattle shedding *Escherichia coli* O157:H7 in feces, and to look for relationships between pen prevalence and other characteristics of the pen. Feces were collected from the rectum of all cattle in each of 29 pens from 5 midwestern feedyards. Fecal samples were subjected to selective enrichment, immunomagnetic separation, and selective plating. Isolates were tested by latex agglutination, standard identification methods and confirmation by PCR for genes coding O157, intimin, and shiga toxin. Each pen was tested once during the June-September study period. Pen size ranged from 36 to 231 (median 107) cattle. At sampling, cattle had been in the feedyard 19 to 108 (median 54) days, and the mean body weight per pen ranged from 347 to 533 kg (median 422 kg). Some cattle in every pen were shedding *E. coli* O157:H7 in the feces. The prevalence of cattle shedding detectable levels of the organism ranged from 0.7% to 79.8% (median 17.1%). Feedyards did not differ by pen prevalence (Kruskal-Wallis $P > .10$); however, the pen prevalence differed widely within feedyards (chi square $P < .001$). Pen prevalence was not correlated with pen characteristics such as temperature, pH, or cleanliness of the water in water tanks, pH of feed in the bunks, number of cattle, mean body weight, or number of days in the feedyard (Spearman rank correlation $P > .1$). Pen condition subjectively evaluated as dry, normal, or wet, was associated with the level of pen prevalence (Kruskal-Wallis $P < .05$). Specifically, wet pen conditions were associated with higher pen prevalence than pens in normal condition (Wilcoxon rank sums $P = .01$). *E. coli* O157:H7 should be considered an ubiquitous organism in pens of feedlot cattle; however, factors related to the pen environment may help explain the level of shedding by feedlot cattle.

Key Words: Feedlot cattle, *Escherichia coli* O157:H7, Food safety

43 Effects of intranasal versus intramuscular modified live vaccines and vaccine timing on health and performance of newly received beef steers. G. C. Duff*, K. J. Malcolm-Callis, D. A. Walker, M. W. Wiseman, M. L. Galyean, and L. J. Perino, *Clayton Livestock Research Center, New Mexico State Univ., Clayton, NM*.

Two studies were conducted to evaluate the effects of infectious bovine rhinotracheitis-parainfluenza3 (IBR-PI₃) vaccines and timing of vaccination on health and performance of newly received beef steers. In Exp. 1, two loads (120 steer and bull calves and 108 heifer calves for Loads 1 and 2, respectively) were used. Treatments were: 1) no vaccine (**Control**); 2) an intranasal (IN) IBR-PI₃ vaccine; and 3) an intramuscular (IM) IBR-PI₃ vaccine. Averaged across loads, no differences ($P > .10$) were noted for daily DMI during the study. For the 28-d receiving period, cattle given IN had a greater ADG ($P < .05$) and improved feed:gain than those given IM. No differences ($P > .10$) were noted among treatments for morbidity. In Exp. 2, 102 steer and bull calves were used, with treatments of: 1) Control; 2) no vaccine at processing, with an IM multiple antigen (IBR-PI₃-Bovine Viral Diarrhea-Bovine Respiratory Syncytial Virus; **IM-MA**) on d 7; 3) an IN IBR-PI₃ at processing with IM-MA on d 7; and 4) IM-MA at processing and on d 7. Daily DMI did not differ ($P > .10$) during the experiment. For d 15 to 28, animals given vaccines had greater ($P < .05$) ADG than controls, and those given vaccines at processing had greater ($P < .05$) ADG than those given delayed vaccination. For d 15 to 28 and the overall 28-d period, feed:gain was improved ($P < .10$) for vaccinated calves vs controls and improved ($P < .10$) from d 15 to 28 for animals vaccinated at processing vs delayed vaccination. No differences were noted for morbidity. Results suggest that when given only at processing, an intranasal IBR-PI₃ vaccine might have beneficial effects on gain and feed efficiency, but that there was no advantage to delaying vaccination until 7 d after arrival. In addition, modified live vaccines did not negatively affect performance during the first 7-d, and vaccines did not affect morbidity during the receiving period compared to controls.

Key Words: Beef cattle, Vaccines, Performance

44 Large round bale feeder design affects the occurrence of aggressive interactions in beef cows. L. Korzun*, D.D. Buskirk, T.M. Harrigan, D.R. Hawkins, and A.J. Zanella, *Michigan State University, East Lansing, MI*.

Round bale (RB) hay feeders are widely used but the impact of their design on behavior, welfare and performance of cows has not been investigated. Non-lactating, gestating beef cows (n=80) were used to evaluate four designs of RB feeders. Cows were allocated to one of four treatments in four outside pens. Each pen was assigned to one RB feeder treatment: I) Ring (R), II) Cone (C), III) Cradle (CR), or IV) Trailer (T). Cows were given *ad libitum* access to hay in the feeders. A video camera was installed in each pen and continuous recording was carried out from 800 to 1800 h for five days using time lapse video photography. Tapes were decoded using check sheets. Five minutes of continuous observation was carried out every thirty minutes from 830 to 1730 h. Each experimental group was observed for 475 minutes (19 observations/day x 5 minutes x 5 days). The frequency of feeding bouts and aggressive interactions around the feeder was recorded. Data were analyzed using SAS[®]. The frequency of aggressive interactions was affected by feeder design. Animals which had access to the R and C feeders showed lower frequency of aggressive interactions than animals kept in the T or CR treatment group ($p < 0.001$). The number of aggressive interactions/5min observation recorded for R, C, T and CR feeders (Mean SEM) was: R= 0.48 0.055; C=0.58 0.055; T=1.210.055 and CR=1.850.055. The study of animal behavior is typically considered in relation to welfare issues. This work, however, showed that behavioral data might help to improve the design of round bale feeders. The shape of the feeder correlated with the number of observable aggressive interactions and this may contribute to the amount of hay wasted. We hypothesize that animals fed by circular feeders perceived less obstacles in their flight zone and therefore were less likely to actively displace other animals. By using behavioral data to design feeders, producers will be able to save considerable feed cost and improve the welfare of cows.

Key Words: Feeding behavior, beef cattle, aggressive interactions

45 Effect of a tylosin tartrate pellet included with component brand implants on the incidence of implant site abscesses in steers and heifers. W. G. Zollers, Jr.*¹, D. L. Cook¹, T. H. Janes², W. E. Barton², and G. D. Hindman¹, ¹*Ivy Laboratories, Overland Park, KS*, ²*CAVL, Inc., Amarillo, TX*.

Implanting growth promotants in the middle one-third of the ear of feedlot cattle breaks the skin in a highly contaminated area, which can lead to formation of an implant site abscess. The implant site abscess rate generally averages 5 to 8% but can exceed 15% in a single pen of cattle. Abscesses result in unrealized gains totaling millions of dollars in loss for the cattle industry. Although programs to promote sanitation during the implanting process reduce the rate of abscess formation, implant site abscesses are not completely eliminated. Adding a separate pellet of tylosin tartrate, an antibacterial agent, to the implant could proactively reduce abscess incidence. An implant site abscess induction model was developed to reliably create a 100% abscess rate in test animals. This model was used to test the ability of a tylosin tartrate pellet to reduce implant site abscess incidence in animals expected to develop an implant site abscess. Two abscess challenge studies were completed to test Component steer implants and Component heifer implants with and without the tylosin tartrate pellet. In both studies, abscesses were induced in all cattle at implanting (Day 0). Implant sites were observed on Day 6, 10, 16, 21, 28 and 35 postimplantation. In the steer study, three Component implants (TE-S, T-S and E-S), each with and without the tylosin tartrate pellet, were tested. For each Component implant on each day of observation, abscess rate was significantly lower ($P < 0.001$) in steers treated with the tylosin tartrate pellet. In the heifer study, two Component implant formulations (TE-H and E-H), each with and without the tylosin tartrate pellet, were tested. For each Component implant at each implant site observation, abscess rate was significantly lower ($P < 0.0001$) in heifers treated with the tylosin tartrate pellet. Results prove that significantly fewer implant site abscesses are induced if a tylosin tartrate pellet is added to the implant.

Key Words: Implant, Cattle, Implant Site Abscess

46 Influence of ear injection of a clostridial vaccine on performance, growth implant payout and infrared thermal characteristics of beef heifers. D. A. Blasi*¹, J. M. Sargeant¹, M. F. Spire¹, S. I. Paisley², and J. E. Minton¹, ¹Kansas State University, Manhattan, Kansas, ²Kansas State University, Hutchinson, Kansas.

A 129-d study was conducted to evaluate the effect of a clostridial bacterin-toxoid (Alpha-7[®]) administered subcutaneously at the base of the ear on growth performance, surface ear temperature, and growth implant payout. Two hundred previously non-implanted British crossbred heifers averaging 169 kg were assigned upon arrival to one of four treatments: 1) Alpha-7 in left neck, Synovex-H[®] in left ear (CL; n=33); 2) Alpha-7 in left neck, Synovex-H in right ear (CR; n=33); 3) Alpha-7 in right ear, Synovex-H in left ear (OP; n=67); and 4) Alpha-7 in right ear, Synovex-H in right ear (SM; n=67). On d 7 the right ear of all heifers were thermographically imaged. On trial d 7, 28, 59 and 87 a blood sample was collected via jugular venipuncture to determine if ipsilateral placement of vaccine impeded implant payout. Vaccinating in the base of the ear (SM + OP) increased ear temperature (28.9 vs 29.6° C; P<.01) compared to neck vaccination (CL + CR); however, liveweight gains during the first 28 days were similar (PY.44) for heifers implanted in the neck versus those implanted in the base of the ear (14.5 vs 13.8 kg). Additionally, ear temperature and animal performance were similar (PY.11) for opposite (OP) and same ear (SM) placement of vaccine and implant. Testosterone concentrations were similar (P>.84) for heifers implanted in the right ear, regardless of the site of vaccination. Concurrent same side use of growth promotant implants and Alpha-7 subcutaneously in the base of the ear does not appear to influence daily gain when compared to ear vaccination with implant placement in the opposite ear. Moreover, it does not appear to influence implant payout as evidenced by similarities of circulating testosterone values to animals receiving only an ear implant without same side vaccination.

Key Words: Clostridial vaccine, Ear injection site, Heifers

47 Effect of nine years of grazing native grass pastures half vs three-quarter season on steers' gains the following year. F. K. Brazle*, Kansas State University, Manhattan.

Three hundred thirteen mixed breed steers (254 kg) were used to determine the effect of nine years of grazing native grass pastures 1/2- vs 3/4-season on the following year's steer gains when grazed to July 15. Steers were allotted randomly to eight pastures previously grazed to either: 1) July 15 (1 steer/.81 hectare from April to July 15, 81 d [J15]), or 2) August 15 (1 steer/1.21 hectare from April to August 15, 112 d [A15]). In 1999, the steers were grazed 83 days, stocked at 1 steer/.81 hectare. The J15 pasture had a greater improvement in percentage of basal cover of perennial grass after nine years of grazing than the A15 (14.7% vs 11.5% improvement, P<.05). The steers were dewormed and deloused with Ivermectin, vaccinated for IBR, BVD, PI3, and BRSV, and implanted with Ralgrö. The steers received free-choice mineral and were supplemented six times with .9 kg of a 20% crude protein range cube to aid in penning the steers. The steers that grazed A15 pastures gained faster (1.59 vs 1.52 kg, P<.01) than the steers grazing J15 pastures. The pastures previously grazed on J15 (1990 - 1998) appeared to have taller grass left after the 1999 grazing season than the A15 pastures. The 1999 season was extremely wet until July 15 which may be a factor in the difference in gain. Long-term grazing until August 15 has previously concerned cattlemen because of long-term damage to the grass and poor performance of cattle grazing A15 pastures the following years. Therefore, this study clearly shows no negative effect on the following year's gains when grazing until August 15 during a wet year. Other weather conditions could change the results.

Key Words: Native Grass, Grazing Systems, Stocker Cattle

48 Integration of pasturing systems for cattle finishing programs. H. Koknaroglu* and M.P. Hoffman, Iowa State University, Ames, IA.

A three-year study was conducted to integrate pasturing systems with drylot feeding systems. Each year 84 fall-born and 28 spring-born calves of similar genotypes were used. Fall-born calves were started on test in May, and spring-born calves were started in October. Seven treatments were imposed: 1) fall-born calves directly into feedlot; 2 and 3) fall-born calves put on pasture with or without an ionophore and moved to the feedlot at the end of July; 4 and 5) fall-born calves put on pasture with or without an ionophore and moved to the feedlot at the end of October; 6 and 7) spring-born calves put on pasture with or without

an ionophore and moved to the feedlot at the end of October. A 12.1 ha bromegrass pasture was available and divided into 16 paddocks of 0.69 ha each. Each treatment group had access to one paddock at a time and was rotated through one of four paddocks at approximately 3 day intervals. In the feedlot, steers were provided an 82 % concentrate diet containing whole-shelled corn, ground alfalfa hay, a protein, vitamin and mineral supplement containing ionophore and molasses. When pens of cattle reached approximately 522 kg average live weight, they were processed and hot carcass weights, 12th rib fat thickness, ribeye area, KPH, yield and quality grades were obtained. Cattle on pasture receiving ionophore gained faster (P=.009), but lost this advantage in drylot (P>.10). Overall, cattle started directly in the feedlot had higher gains (P<.001). Cattle receiving an ionophore on pasture had lower KPH than those that did not receive an ionophore (P<.01) and tended to have more backfat (P=.09). Treatment influenced yield grade (P<.001), although all treatments were YG 2. The percentage of cattle grading Prime and Choice was 75 % or higher for all treatment groups and was higher for fall-born calves spending more time in drylot. The results show that using an ionophore improved pasture gains and that pasture treatments did not adversely influence yield and quality grades.

Key Words: Steers, Feedlot, Pasture

49 Factors affecting beef cattle performance and profitability in Iowa. H. Koknaroglu*, D. D. Loy, D. E. Wilson, M. P. Hoffman, and J. D. Lawrence, Iowa State University Ames, IA.

Close-out information, consisting of 1,836 pens of cattle and placed on feed between January 1988 and December 1997, submitted by Iowa cattle producers using the Iowa State University Feedlot Performance and Cost Monitoring program was examined to determine factors affecting beef cattle performance and profitability. Information provided on close-out sheets was: start date, end date, cattle per pen, sex, housing type, days on feed, initial weight, sale weight, feed conversion (FC), percent concentrate, ADG, percent death loss, feed cost per cwt gain, total cost per cwt gain, breakeven price, nonfeed variable cost, nonfeed fixed cost and corn price. Feeder cattle prices were calculated as feeder cattle price = (breakeven price x sale weight - total cost of gain x gain)/ initial weight. Gains in cwt were calculated as gain = (sale weight - initial weight)/100. Fed cattle prices were obtained weekly from the report published by USDA for Southern Minnesota and Iowa. Profit per head was calculated as profit = (sale weight x fed price - (total cost of gain x gain + feeder price x initial weight)). Steers consumed more feed, gained faster and were more efficient than heifers (P<.01) and tended to be more profitable (P>.30). Housing type influenced DMI, ADG and FC (P<.01), with sheltered cattle generally gaining more and being more efficient. With increasing initial weight, DMI and ADG increased, and cattle became less efficient (P<.01). Cattle ate less, gained more and became more efficient with increasing concentrate level (P<.01). Cattle receiving low levels of concentrate were most profitable and those receiving intermediate levels were least profitable (P<.01). Season affected DMI and FC (P<.05). Cattle started in spring and fall were slightly more profitable than those started in winter and summer (P>.10). As the number of cattle per pen increased, DMI and ADG decreased (P<.01), whereas FC did not differ (P>.40). The less cattle per pen the more profit per head (P<.01). Feeder and fed cattle prices explained over 75 % of the variation in profitability.

Key Words: Steers, Performance, Profitability

50 Relative profitability of fall and spring calving in northern Missouri grazing systems. L. L. Melton*¹ and C. J. Kaiser², ¹New Mexico State University, Las Cruces, ²University of Missouri, Columbia.

Our objective was to determine the effect of calving season on profitability under a forage based cow/calf management system, typical of northern Missouri. Using the Decision Evaluator for the Cattle Industry (DECI), a mechanistic, herd based simulation program, we designed four treatments to simulate cow herds. Each treatment was replicated twenty times with random variation of animals as a component. All combinations of fall or spring calving, and high (n=383) or low (n=300) stocking rates were simulated. Cattle were run on a forage base typical of northern Missouri improved pastures. No supplementation was provided, other than hay fed January 1 through April 15. Calves were weaned at an average of 205 days and sold at weaning. Each replication was run for 20 years, and data for years 9 through 19 of each replication were used for comparison. The amount of hay consumed, market

weight of calves, and sale weight of cull animals were used to measure the relative profitability based on market prices. Hay production was valued at typical production cost. The number of calves weaned and total pounds of calf weaned were higher for the fall versus spring calving system, but did not differ between stocking rates. These results suggest a fall calving season would increase profitability under current Missouri production systems.

Key Words: Beef Cattle, Calving Seasons, Simulation Model

52 A chronic model of performance and thermoregulatory responses to ergot bodies. P.A. Eichen, D.E. Spiers, G. Rottinghaus, and K. Fritsche*, *University of Missouri, Columbia, Missouri.*

There is growing concern that cattle consuming ergot bodies, found in barley infected with the fungus *Claviceps purpurea*, might experience problems similar those characteristic of fescue toxicosis. Such problems might include hyperthermia, together with decreased rates of feed intake and growth. Ergot bodies (EB) contain ergopeptine alkaloids (EA) that include ergosine, ergocornine, ergocryptine and ergocristine, but not ergovaline (i.e., the primary toxin in endophyte-infected tall fescue (EIF) that produces fescue toxicosis). In previous studies, rats fed EIF displayed core temperature changes similar to those seen in cattle fed EIF. The present study was performed to determine the response to EB. Twelve 50 day-old, male rats were implanted with telemetric transmitters (Mini-Mitter, Sunriver, OR) to continuously monitor core body temperature (Tcore) and activity. All rats were housed at thermoneutrality (TN; 21C) and initially fed a control (C) diet. After two weeks equilibration, rats were randomly assigned to either EB diet (formulated to deliver approximately 834mg EA/kg BW/day at TN) or C diet and maintained at TN for one week. They were then exposed to heat stress (HS; 31C) for two weeks. Body weight and feed intake were measured daily. Rats receiving EB showed decreased feed intake ($P < .0001$) and weight gains ($P < .0001$) immediately upon introduction of EB diet. During HS, C rats showed decreased feed intake ($P < .0001$) and EB-fed rats had further decreases in feed intake ($P < .0001$) and weight gains ($P < .0001$). Rats fed EB diet displayed higher Tcore during early and mid-HS ($P < .0001$) than those receiving C diet. During late HS, some adaptation appeared to be occur, when EB-fed rats had slightly lower Tcore that approached the level in C rats ($P < .005$). The rat model of chronic response to ergot bodies shows many responses similar to those for fescue toxicosis. However, the dose required to generate this response is much higher than the dose of ergovaline needed to produce fescue toxicosis.

Key Words: rat, ergot body, heat stress

53 Assessment of feedlot cattle responses to heat stress using continuous monitoring methods. M.J. Leonard*¹, D.E. Spiers¹, and G.L. Hahn², ¹*University of Missouri, Columbia, Missouri*, ²*USDA-ARS, U.S. Meat Animal Research Center, Clay Center, Nebraska.*

Feedlot cattle exposed to summer heat in the absence of shade experience loss of performance and increased mortality risk. A 14-day field study was conducted during the summer of 1999 to assess body core temperature (Tcore) responses to heat challenge within a normal production system, and identify useful environmental determinants of increased thermal load. Twelve Angus x Simmental steers (Avg BW 533kg) were kept in an unshaded feedlot pen, and provided typical finishing diet and water ad libitum. Cattle were implanted intra-peritoneally with telemetric transmitters (CowTemp, Model BV-010) to continuously monitor Tcore. Thermal conditions were recorded using data loggers (Onset "Hobo"), and included percent relative humidity, air temperature, and black globe temperature for assessment of radiant heat load. Both temperature-humidity (THI) and black globe temperature-humidity (BGTHI) indices were calculated using these values. Linear increases in Tcore occurred above 23.5C (Ta) and 31.8C (BG). Correlation coefficients above these critical temperatures for relationships of Tcore to Ta and BG were 0.74 ($P < .001$) and 0.72 ($P < .001$), respectively. Temperature-humidity index is often used as a measure of potential heat stress. The correlation between Tcore and both THI and BGTHI was made above critical cut-off values for these categories (>75 = alert, >79 = danger, >84 = emergency). Each index value showed a linear relationship ($P < .001$) with Tcore (THI >75 , $r = .62$; >79 , $r = 0.69$; >84 ,

$r = 0.71$) (BGTHI >75 , $r = 0.70$; >79 , $r = 0.71$; >84 , $r = 0.65$). While all showed linear responses, Ta was the better predictor of thermal stress. However, BGTHI compared to THI showed a higher level of correlation with Tcore, especially at lower levels of stress. Further studies using continuous monitoring methods will quantify the effect of solar radiation on performance for improved prediction of the impact of heat stress on performance.

Key Words: cattle, heat stress, radiant heat

54 Impact of wean-to-finish management on growint-finishing pig performance. M.C. Brumm*¹, A.K. Baysinger², E.T. Clemens¹, R.W. Wills¹, and R. Thaler³, ¹*University of Nebraska, Concord, NE/USA*, ²*Alpharma, Inc., Ft. Lee, NJ/USA*, ³*South Dakota State University, Brookings, SD/USA.*

An experiment was conducted using crossbred PIC barrows to determine the impact of a wean-to-finish housing system on pig performance during the growing-finishing phase of production. Treatments (4 replicates in each of 3 trials) were: 1) wean-to-finish (WF) in 2.4 x 4.3 m pens (15 pigs/pen) from weaning to slaughter; 2) double stock WF during the 8 week nursery phase randomly split into pigs that stayed in same pen (DSS) and pigs that moved to new pen (DSM); and 3) pigs moved from nursery at 8 weeks post-weaning to finishing facility (N) with WF, DSS and DSM treatments. The facility was fully slatted, naturally ventilated and provided .69 m²/pig with 15 pigs/pen for all treatments. There were two 35.6 cm wide feeder spaces and one cup drinker per pen. There was a nursery treatment effect on initial weight for the grow-finish phase (WF, 28.7 kg; DS 26.9 kg; N 27.7 kg; WF vs DS $P < .005$; WF vs N $P < .075$). While there were differences in the number of pigs dead and treated between trials attributable to source of pigs at weaning, there were no trial by treatment interactions ($P > .15$). There was no effect of treatment ($P > .1$) on daily gain (.850, .857, .838, .843 kg/d), daily feed intake (2.305, 2.293, 2.271, 2.293 kg/d) or feed conversion efficiency (.369, .374, .369, .368) during the finishing phase for the WF, DSS, DSM and N treatments respectively. There was no effect of treatment on carcass % lean (51.5, 51.6, 51.3, 51.6) or lean feed conversion efficiency (.137, .142, .138, .138) for the WF, DSS, DSM or N treatments, respectively. There was also no effect of treatment ($P > .1$) on variation of within pen weight when the first pig was removed for slaughter as measured by CV of within pen weight (9.3, 10.4, 11.3, 10.5 respectively). These results, when combined with the earlier reported nursery phase data suggest that the wean-to-finish response is a nursery phase response with no difference in performance between the treatments during the growing-finishing phase.

Key Words: Pigs, Grow-Finish, Wean-Finish

55 Effects of group size, floor space, and feeder placement on nursery pig performance. B.F. Wolter*¹, M. Ellis¹, S.E. Curtis¹, E.N. Parr², and D.M. Webel², ¹*University of Illinois*, ²*United Feeds, Inc.*

Two experiments were conducted to evaluate effects of pen features on pig performance. In Exp 1, 1920 pigs (17 d; 5.3.7 kg BW) were used in two 9-wk trials (4 rep/trial) employing RCB design in a 2x2 factorial arrangement of treatments: group size (20 [S] or 100 [L] pigs/pen) and floor space (calculated requirement [CR] or calculated requirement less 50% estimated "free space" [CR-50]). "Free space" (McGlone and Newby, 1994) was estimated for each group size. Space allowances for wk 1-4 were .17 m²/pig for the CR treatment for both group sizes and .15 and .13 m²/pig for CR-50 treatment for S and L groups, respectively. Equivalent spaces for wk 5-9 were .38 m²/pig for the CR treatment and .32 and .28 m²/pig, for the CR-50 treatment for S and L groups, respectively. Pigs had free access to feed and water. Feeder space per pig was equal across treatments (5 pigs/20 cm). Feed-intake (FI) data were collected wk 1-4 only. There were no interactions between group size and floor space. Pigs in L groups were lighter ($P < .001$) than those in S groups at end of wk 1, 4, and 9 by 2%, 4%, and 5%, respectively, and had lower average daily gain (ADG) (6%, $P < .001$) wk 1-9. During wk 1-4, FI was lower (7%, $P < .001$) for pigs in L compared to S groups, but gain:feed (G/F) was similar ($P > .05$). Pigs with CR floor space had higher ADG (5%, $P < .01$) wk 1-9, had higher G/F (3%, $P < .05$) wk 1-4, and were heavier ($P < .01$) than pigs with CR-50 floor space at end of wk 4 (3%) and 9 (4%). Pigs in L groups had larger CV in BW than in S groups at end of wk 9 (12.3% vs 11.1%, $P < .05$). In Exp 2, 1760 pigs (17

d; 5.6.7 kg BW) were used in two 4-wk trials (4 rep/trial) to evaluate effects of feeder placement on pig performance. Treatments were: 1) large group (100 pigs/pen) with multiple (5) feeder locations (LM); 2) large group (100) with single feeder location (LS); and 3) small group (20) with single feeder (SS). Floor space (.17 m²) and feeder space (4 cm) per pig were equal across treatments. Pigs in both LM and LS treatments were lighter (2%, P<.01) at end of wk 4 and had lower (P<.01) overall ADG (5%) and FI (5%) than SS pigs. The G/F were similar (P>.05) across treatments. In summary, large group size and reduced floor space decreased pig performance, and providing multiple feeder locations did not increase pig FI, ADG, or G/F in large groups.

Key Words: Pig, Group Size, Pen Design

56 Examination of the interactive effects of stocking density and marketing strategies in a commercial production environment. J. C. Woodworth*, S. S. Dritz, M. D. Tokach, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan.*

A total of 1,272 pigs (initially 29 kg) was used to test the interactive effects of stocking density and marketing strategy on growth performance, carcass characteristics, and carcass value of pigs in a commercial environment. Experimental treatments were arranged in a 2×2×3 factorial with main effects of sex (barrows (B) vs. gilts (G)), stocking density (25 (.67 m²/pig) vs. 28 (.59 m²/pig) pigs per pen), and marketing strategy (0 (0S), 1 (1S), or 2 (2S) sorts before close out). Four pigs were marketed 21 d prior to close out for the 1S treatment and 2 pigs were marketed at 27 d and 3 pigs marketed at 14 d prior to close out for the 2S treatment with the remainder of the pigs marketed 117 d after placement. All diets were corn-soybean meal based and were formulated in five phase weight ranges for each gender with total dietary lysine levels of 1.22, 1.05, .90, .72, and .62; and 1.22, 1.10, .95, .75, and .65 for barrows and gilts for the five phases, respectively. No 2 or 3-way interactions were observed for the entire trial. Barrows had (P < .05) greater ADG and ADFI, greater percentage that reached acceptable market weight (tops), greater fat depth, less loin depth and lean percent, a lower fat-free lean index, and had a lower lean premium compared to G. Stocking density had no effect (P > .10) on growth performance, carcass characteristics, or carcass value. Average daily gain from d 90 to 117 was lowest (P < .05) for pigs from 0S pens compared to pigs from 1S pens. Pigs from 0S pens were heavier (P < .05) than pigs from 2S pens. Carcass characteristics were not influenced by marketing strategy; however, sort discount was greater (P < .05) for pigs from 0S pens compared to pigs from 1S or 2S pens (.76 vs. .49 and .48 \$/cwt, respectively). In summary, pen densities did not influence growth performance or carcass characteristics in this trial. Marketing strategy influenced growth performance and weight discounts during the marketing period, but had no effect on carcass characteristics.

Key Words: Pigs, Pen density, Marketing strategy

57 Effect of group sizes of 10, 20, 40 and 80 on productivity of grower-finisher pigs. S.A. Schmolke*^{1,2} and H.W. Gonyou¹, ¹*Prairie Swine Centre Inc.*, ²*University of Saskatchewan, Saskatoon, Canada.*

Research on management and productivity of grower-finisher pigs has generally been conducted with small group sizes while the swine industry has shifted towards larger group sizes. The objective of this study was to quantify effects of four group sizes (10, 20, 40 and 80 pigs) on productivity. Each of four replicates was comprised of two pens of 10 pigs, and one pen each of 20, 40 and 80 pigs. Each pen contained an equal number of males and females, with pigs born within a 2 wk period. Initial BW of pigs was 23.2 ± .2 kg. One wet/dry ad-libitum feeder was provided for every 10 pigs and spaced equidistantly along one side of the pen wall. Space per pig was constant among group sizes. Pigs were weighed every 2 wk to obtain ADG, ADFI and feed efficiency data. Injury scores were collected 48 hr post-regrouping on four body zones. Data was analyzed as a split-plot with group size as the main plot and gender as the sub-plot. Morbidity was analyzed using χ^2 . The ADG from wk 0 to 12 was greater for males (890 g/d) than for females (830 g/d; P < .05). ADG for the entire 12-wk trial was not affected by group size (862, 873, 853, and 846 g/d, for pens of 10, 20, 40 and 80, respectively; P > .10). ADG was reduced in groups of 40 (554 g/d) compared to 10 (631 g/d) and 80 (605 g/d) during wk 0 to 2 (P < .05), and in groups of 40 (903 g/d) and 80 (891 g/d) compared to 10 (975

g/d) during wk 4 to 6 (P < .05). ADFI from wk 0 to 12 was similar among group sizes (2.34 ± .08, 2.42 ± .11, 2.23 ± .11 and 2.27 ± .11 kg/d, for pens of 10, 20, 40 and 80 respectively; P > .10). Injury scores were similar among group sizes (P > .10), but flank injuries were more severe for females than for males (P < .05). Morbidity for pigs did not differ among group sizes (7.5, 6.2, 5.0 and 5.6% for pens of 10, 20, 40 and 80, respectively; P > .10). In summary, productivity did not differ between group sizes of 10, 20, 40 and 80 pigs.

Key Words: Swine, Grower-finisher, Group size

58 Sow performance using electronic sow feeding versus conventional feeding systems. D. B. Edwards*¹, R. O. Bates¹, and R. L. Korthals², ¹*Michigan State University, East Lansing,* ²*Osborne Industries, Inc., Osborne, KS.*

Few comparisons of electronic sow feeding (ESF) to conventional sow feeding systems have been conducted. Osborne Industries Inc. 300-sow Demonstration Farm compared ESF to conventional stalls. Sow breeding, gestation, and lactation performance were assessed from October 1994 to June 1997 over multiple parities. Treatments included ESF in gestation (EG), gestation in stalls (CG), ESF in lactation (EF), and lactation in stalls (CF). Sows were group housed in both gestation and lactation ESF treatments. Sows did change treatments from parity to parity based on the production schedule. Average lactation length over all parities was 20.9 d. Data analyses were completed by parity. Number born live and total number born were not affected by either gestation or lactation treatment over all parities. Litter birth weight (LBW, kg) was higher with EG than CG in parities 3 (19.23 vs 17.45; P<.10) and 6 (17.46 vs 15.63; P=.12). An interaction of lactation and gestation treatments was observed (P=.10) in parity 7 for LBW. Within CF, gestation treatment did not affect LBW. Within EF, EG sows had heavier LBW than CG sows (16.69 vs 14.53; P<.01). Number weaned was higher for CF over EF in parities 1 (9.07 vs 8.02; P=.12), 2 (9.43 vs 8.75; P=.14), 3 (9.35 vs 8.76; P<.10), and 5 (9.11 vs 7.31; P<.05), due to increased pre-weaning mortality with group housed sows. Return to estrus (%) after weaning was higher for sows in EG than CG in parities 2 (93.5 vs 87.2; P=.13) and 4 (98.2 vs 93.1; P<.10) Return to estrus within 7 d (%) after weaning was higher for sows in EG than CG in parities 2 (66.4 vs 56.4; P=.11) and 6 (82.1 vs 69.1; P<.05). Sows housed in gestation ESF had similar or improved performance over conventional stall housed sows. Sows housed in lactation ESF had similar performance to conventional stall housed sows with the exception of number weaned, due to increased pre-weaning mortality in group housing. Ongoing research in farrowing pen design should improve pre-weaning mortality for group housed sows.

Key Words: Electronic Sow Feeding, Lactation, Gestation

59 Effects of off-sow rearing upon *Campylobacter* colonization in neonatal pigs. R.B. Harvey*¹, R.E. Droleskey¹, R.C. Anderson¹, K.J. Genovese¹, L.A. Egan², and D.J. Nisbet¹, ¹*Food and Feed Safety Research Unit, ARS, USDA, College Station, TX USA,* ²*College of Veterinary Medicine, Texas A&M University, College Station, TX USA.*

There are increased concerns about the prevalence of *Campylobacter* in pigs and the potential public health risks for *Campylobacter* transmission to humans from pork products. We conducted a study to determine how *Campylobacter* colonization of the gastrointestinal tract is affected when piglets are removed from the sow within 24 h of birth. Twenty-nine, one-day-old piglets (from 9 different sows) were purchased from a commercial swine operation and were reared in our laboratory on wire-floored farrowing crates and fed commercial milk replacer for 21 days. Fifteen littermates (from the same 9 sows) of the above piglets were reared on their dams on the farm. Rectal swabs were collected daily for 21 days from the off-sow, laboratory-reared piglets and cultured for the presence of *Campylobacter*. Rectal swabs from the sow-reared piglets were collected on d 1, d 12, and d 20 and cultured for *Campylobacter*. Swabs were enriched in Bolton's broth, incubated for 24 h at 42 C, 10 μ L of broth were streaked onto Campy-Cephex agar plates, and plates were incubated at 42 C for 48 h under microaerophilic conditions. At d 1, 8 of 29 (28%) of the off-sow, and 4 of 15 (47%) of the on-sow piglets were positive for *Campylobacter*. By d 2, 12 of 29 (41%) of the off-sow piglets were positive. However, the prevalence of *Campylobacter* decreased steadily in the off-sow piglets from d 2 until d 21 when

there were 6 of 26 (22%) positive. In contrast, the on-sow piglets had a *Campylobacter* prevalence of 14 of 15 (93%) at d 12 and 15 of 15 (100%) at d 20. In the piglets reared in the laboratory, both *Campylobacter*-positive and *Campylobacter*-negative piglets could be found in the same pens. These data suggest that initial colonization of piglets by *Campylobacter* occurs within the first 48 h of birth, but that successful permanent colonization is probably associated with continuous exposure to the organism. On the basis of our results, reduced prevalence of *Campylobacter* can be achieved by removal of piglets from the sow within the first 24 h of birth.

Key Words: *Campylobacter*, Neonates, Prevalence

60 Effects of genotype, environment, and feed grade antibiotics on serum concentrations of IGF-I and α 1-acid glycoprotein (AGP) and their relationship to swine growth. T.E. Weber^{*1}, B.T. Richert¹, D.C. Kendall¹, A.P. Schinckel¹, and P. Matzat², ¹Purdue University, West Lafayette, IN, ²Roche Vitamins, Parker, CO.

Gilts (n=440) at an average age of 14 days were randomly assigned to a 2x2 factorial with two genotypes (Pietrain based x PIC (P) and Large White based x PIC (L)) and two nursery antibiotic treatments: medicated (NMED, Denagard/ASP-250) and non-medicated (NNM). At d 49 the pigs were randomly assigned to continuous flow (CF) or all-in/all-out finishing facilities (AIAO) and finisher dietary antibiotic treatment (FMED, Aureomycin) or non-medicated (FNM) in a 2⁴ factorial design during the finishing phase. Serum samples were harvested from a subset of pigs (n=60) at d 21, 41, 90 and 132 to determine the concentrations of IGF-I and AGP. Pigs were weighed biweekly to determine ADG. Last rib backfat (P2), 10th rib backfat, and 10th rib longissimus muscle area (LEA) were measured via real time ultrasound on d 49, 70, 104, 132, and 153. NMED increased serum IGF-I at d21 (P=.04) and d90 (P=.002) and decreased serum AGP at d21 (P=.01). Genotype had an effect on serum IGF-I with P pigs having greater serum IGF-I than L pigs at d90 (P=.04) and d132 (P=.004). There was no effect (P>.9) of finisher antibiotic on IGF-I at d90 and d132. An interaction (P=.01) between nursery and finisher antibiotic occurred at d90 with NMED-FMED having greater IGF-I than NMED-FNM while NNM-FMED had lower IGF-I than NNM-FNM. An interaction (P=.009) between genotype and nursery antibiotic occurred at d132 with L-NMED having greater IGF-I (P=.005) than L-NNM with no difference between P genotype treatment groups. Pigs reared in AIAO had higher levels of IGF-I at d132 than CF (P=.03). There was a negative relationship between AGP and IGF-I (r=-.42, P=.0008). The data indicated no relationship between IGF-I and ADG (r=-.15, P=.24), P2 (r=-.19, P=.14), or LEA (r=-.07, P=.60). These results demonstrate how various management practices can modify serum peptides associated with immune status and growth, and suggest that there are other underlying mediators of growth.

Key Words: pig, antibiotic, IGF-I

61 The evaluation of well-being in early weaned pigs as measured by adaptability. D.C. Lay Jr.* and M.F. Haussmann, Iowa State University.

To date there is a lack of consensus as to the long-term biological impact early weaning has on the welfare of the early-weaned pig. The objectives of this study were to determine if early weaning: 1) altered the pigs' ability to respond to stress; or 2) affected the pig's well being. Six pigs from each sow (n = 8 per treatment) were either early weaned (EW, 10-d of age) or weaned at 30-d of age (LW). At the time of weaning, pigs were observed for 5-d after weaning and at 8-wk of age using time-lapse photography and direct observations. Time spent lying, eating, active and performing aberrant behavior was recorded from the video; vocalizations, social interactions, and agonistic behaviors were recorded during direct observations. At 12-wk of age, one pig from each litter (n = 8 per treatment) was subjected to an isolation test, in which they were removed from their pen and placed in a 61 x 61 cm box. Blood and heart rate samples were collected at: 0 (home pen), 15, 30, 45, 60, and 90 (home pen) min. Differential leukocyte counts were determined for the 0, 30, and 90-min blood collections. The LW pigs spent more time eating during the 5-d after weaning (P < .001), but less time drinking (P < .004) than EW pigs. The EW pigs had greater ADG (P < .03) soon after weaning, but this advantage disappeared by 165-d of age. At

8-wk of age, EW pigs tended to fight and root more (P < .07) compared to LW pigs. During the isolation stress, heart and vocalization rates were similar for pigs from both treatments (191 3.3 beats/min and 105.4 17 respectively, P < .90). Differential leukocyte counts were also similar for pigs from both treatments (P < .50). However, the early weaned pigs did express elevated plasma cortisol concentrations (P < .05). Although early weaning altered the pig's corticosteroid response to stress and some behavior patterns during development, it appeared that pigs adapted to their environment; and therefore, we did not find an impairment of the piglets well-being.

Key Words: Swine, Weaning, Stress

62 Evaluation of genotype, strategic use of antibiotics and grow-finish management effects on lean growth rate and carcass characteristics. D.C. Kendall^{*1}, B.T. Richert¹, T.E. Weber¹, K.A. Bowers¹, S.A. DeCamp¹, A.P. Schinckel¹, and P. Matzat², ¹Purdue University, West Lafayette, IN, ²Roche Vitamins, Parker, CO.

Gilts (n=440;14 days of age) were allotted by weight in a 2 x 2 factorial with two genotypes (Large White based x PIC (L) and Pietrain based x PIC (P)) and two nursery dietary antibiotic treatments: medicated (NMED, Denagard/ASP-250) and non-medicated (NNM). At d49, pigs were moved to either a continuous flow finisher (CF; N=192) or an all in/all out finisher (AIAO; N=168) and housed at 6 pigs/pen in a 2⁴ factorial composed of environment (Env), genotype (Gen), prior nursery antibiotic treatment (NT) and finisher dietary antibiotic treatment (FT; medicated (FMED, Aureomycin) or non-medicated (FNM)). Pigs and feeders were weighed biweekly to determine average daily gain (ADG), average daily feed intake (ADFI) and gain:feed (G:F). Real-time ultrasound measurements were taken on 3 pigs/pen at d49, 70, 104, 132 and 153 to calculate lean and fat accretion rates. Pigs were slaughtered at either d153 or d174 of age. During the nursery period, a 10% increase in ADG (475 vs. 430 g/d; P < .001), 8% higher ADFI (P < .001), and less variation in d42 weight (P < .05) occurred for pigs fed NMED diets compared to those fed NNM diets. For the finishing period, pigs in the AIAO Env had higher ADG (881 vs. 787 g/d), ADFI, greater G:F (.37 vs. .35), and were 7.9 days faster to 113 kg than pigs in the CF Env (P < .001). Pigs fed FMED diets had greater ADFI (P < .10) and lower mortality (1.2% vs. 4.9%; P < .05) than those fed FNM diets. FMED and Env influenced the percentage of pigs treated with injectable antibiotics; 3.8, 12.4, 39.4, and 49.7%, for AIAO-FMED, AIAO-FNM, CF-FMED, CF-FNM, respectively. A Gen by Env interaction (P < .05) occurred with the P gilts having 27 g/d higher fat accretion than L gilts in the CF Env but a 5 g/d lower fat accretion in the AIAO Env. NT by FT by Env interactions (P < .05) for ADG, ADFI and days to 113 kg occurred, with pigs fed NMED-FMED diets having better performance than their peers in the CF Env but similar performance to all treatment combinations in the AIAO Env. The strategic use of antibiotics can improve nursery and finisher performance but the level of response varies depending on genotype and health management environment.

Key Words: Pigs, Environment, Antibiotics

63 Exogenous ACTH administration during gestation alters offspring development, immune function and behavior. M. F. Haussmann^{*1}, J. A. Carroll², G. D. Weesner³, M. J. Daniels¹, and D. C. Lay, Jr.¹, ¹Iowa State University, Ames, IA, ²Animal Physiology Research Unit, ARS-USDA, Columbia, MO, ³Purdue University, West Lafayette, IN.

Swine that are chronically stressed may experience adverse effects on development, immune function and behavior. When a pregnant sow is stressed, cortisol crosses the placenta to possibly affect the fetal hypothalamus, a process termed prenatal stress. This study examined the physiology and behavior of pigs whose dams were injected with ACTH during pregnancy resulting in elevated cortisol. Control sows (n = 8) were given no treatment while the treatment sows (ACTH, n = 8) were administered an i.v. injection of ACTH (1 IU/kg BW) weekly from 6- to 12-wk of gestation. A pig from each sow was sacrificed at 1, 30 and 60 d of age. From these pigs, pituitary corticotrope and somatotrope cell numbers, and adrenal gland cortex-to-medulla ratio (CORT:MED) were quantified. Pig behavior was recorded at 6- and 8-wk of age. At 75-d of age, a plasma cortisol concentrations were determined and a biopsy puncture was created on one pig from each litter, then pigs were

stressed by mixing. Every other day for 10-d, plasma cortisol concentrations were obtained and biopsy damage was evaluated for healing. The number of corticotropes and somatotropes in pituitary sections was similar between treatments at 1, 30 and 60 d of age ($P > .60$). The COR:MED was less in control pigs compared to ACTH pigs at 1 and 60 d of age ($P < .04$), but at 30 d of age there was no treatment difference. At 8-wk of age, control pigs performed a higher frequency of belly nosing ($P = .07$) and oral vice behaviors ($P = .01$) than ACTH pigs. In response to mixing stress, control pigs had lesser concentrations of plasma cortisol ($P = .03$) and healed faster ($P = .006$) than ACTH pigs. Thus, if exogenous ACTH administration to pregnant dams replicates the effects of prenatal stress, then chronic stress to sows during gestation may cause developmental alterations to her offspring which may compromise the pigs health and welfare during stressful situations later in life.

Key Words: Pig, Stress, ACTH

64 Composting as a viable alternative to traditional livestock waste disposal. P.M. Walker*, T.R. Kelley, and K.D. Smicklas, *Illinois State University, Normal.*

A major problem facing the Illinois livestock industry is disposal of livestock waste. Historically livestock manure has been spread or injected as a fertilizer on farm fields. Legislation now regulates land application of livestock waste and is becoming increasingly restrictive. Alternative processing methods for handling livestock waste must be developed which are accepted by society. One such processing method is composting. Livestock waste generated by the University farm was aerobically composted using a pull-type windrow turner in uncovered windrows initially measuring 1.52m x 1.52m x 152.4m (w x h x l). Several combinations of raw materials were evaluated as nitrogen sources including liquid swine slurry pumped from anaerobic pits and solid swine waste collected from concrete lots, and as carbon sources including landscape waste and corn stalks. The most desirable combinations observed were 3.5 kg:kg or 226.6 kg:m³, solid waste: landscape waste, respectively, requiring 1.96 tonnes of raw material to produce 1 tonne of compost; 7.02 kg:kg or 553.5 kg:m³ or 583.0 l:m³ slurry: wood chips, respectively, requiring 5.78 tonnes of raw material to produce 1 tonne of compost; 2.10 kg:kg or 500.3 kg:m³ or 416.6 l:m³ slurry: corn stalks, respectively, requiring 1.85 tonnes of raw material to produce 1 tonne of compost. When maintaining C:N between 25:1-30:1 wood chips were found to utilize greater ($P < .05$) amounts swine waste than either landscape waste or corn stalks. All the waste (including liquid manure) produced by a livestock operation up to 700 animal units can be composted with minimal investment. The scope of swine operations over 700 animal units may limit composting to the solids fraction of the liquid slurry due to the volume of carbon source (corn stalks, small grain straw, landscape waste, sawdust, etc.) required. Preliminary calculations have determined the cost for producing finished compost equivalent to \$30:ton.

Key Words: Compost, Alternative, Swine Waste

65 Potential for pathogens to overwinter in swine manure containing ground piglet carcass. L. J. Johnston*, S. M. Goyal, and C. J. Clanton, *University of Minnesota, Morris and St. Paul.*

Responsible disposal of swine mortalities presents continual challenges to pork producers. Adding homogenized piglet carcasses to liquid manure has been studied for recycling nutrients back to cropland with manure. This method raises concerns about survival of pathogens in liquid manure. Our objective was to determine the effects of cold temperatures on survival of selected pathogens in liquid manure stored outdoors.

Piglet carcasses were homogenized using a commercial sized grinder then inoculated with T1 coliphage and *S. anatum*. This carcass-pathogen mixture was combined with liquid swine manure in polypropylene jugs so that carcass dry matter represented 0, 2, 4, or 6% of the total dry matter in the manure. Eight jugs (2 per treatment) were submersed in each of three large tanks of liquid manure (24 total jugs). Tanks, jugs, and their contents were stored outdoors beginning January 22 and allowed to freeze and thaw according to ambient temperatures. Samples were collected from the jugs on days 0, 39, 81, 95, 109, and 158. Concentration of coliphage was higher ($P < .01$) initially in jugs that contained carcass compared with controls (2, 4, or 6% vs 0%). Mean temperature of tanks ranged from -4.9 °C to 25.1 °C. Contents of the tanks froze and thawed twice during the experiment. Samples collected on day 39 at first thaw from 2, 4, and 6% treatments were 163, 336, and 410% higher ($P < .01$), respectively, in coliphage concentration than similar samples from control jugs. This trend continued through day 81. There was no difference ($P > .10$) in concentration of coliphage among treatments on days 95, 109, and 158. *S. anatum* was not detected in any control jugs but was present in 100% of jugs that contained carcass through day 81. On day 95, 66% of carcass-containing jugs harbored detectable *S. anatum*, but none of the jugs contained detectable *S. anatum* on days 109 or 158. Level of carcass added to the jugs had no influence on survival of *S. anatum*. These data indicate that T1 coliphage can survive for up to 95 days and *S. anatum* can survive for up to 109 days over winter in liquid manure containing homogenized piglet carcass.

Key Words: Swine manure, Pathogen, Survival

66 Microbial odor production and odor consumption in cattle feedlot soils under varying environmental conditions. D. N. Miller*, *USDA, ARS, U.S. Meat Animal Research Center.*

This study examined the microbial potential for odor production and odor consumption at a cattle production facility in central Nebraska. Nine samples of two soil types from a cattle feedlot were collected, pooled, and analyzed in triplicate. The first soil was collected near the feed bunk and consisted primarily of fecal matter. The second soil was collected from a run-off ditch below the pen and contained little animal waste. These soils were tested for their ability to produce and consume a mixture of volatile fatty acids (VFAs) and aromatic compounds (phenols and indoles) under fermentative, aerobic, and respiratory anaerobic conditions with nitrate, oxidized iron, oxidized manganese, and sulfate serving as anaerobic terminal electron acceptors over a six-week incubation. In general, aerobic and respiratory anaerobic incubations with nitrate produced very little VFA. Fermentative and respiratory anaerobic incubation in both soils, however, initially produced large amounts (up to 0.35 mmoles/gm soil) of short-chain VFA (mostly acetic and propionic acid), which was then slowly consumed. In contrast, aromatic compound concentrations did not initially increase in any treatments, and selected compounds actually decreased during the incubation. The increase in total VFA was much greater in the pen samples (0.17 to 0.35 mmoles/gm) compared to the ditch soil samples (0.17 to 0.27 mmoles/gm). When VFA consumption was compared across all the treatments, aerobic incubation proved most effective and removed all VFA within two days. Anaerobic incubation with nitrate proved next most effective (VFA removed in 5 days) followed by iron at 20 days. Anaerobic incubation with sulfate showed very little difference compared to fermentative incubation (VFA consumed by day 34 to 41). Anaerobic incubation with oxidized manganese produced the largest amounts of VFA, which remained high throughout the six-week incubation. We concluded from this study that soils at cattle production facilities showed a varying, potentially exploitable capacity for odor consumption.

Key Words: Odor, Microbial Activity, Feedlot Soils

EXTENSION

71 Market research to support the development of a branded meat product: A consumer survey. D.S. Knipe¹, B. Wansink¹, R.K. Knipe*¹, A.R. Cobb¹, D. Jennings¹, H.K. Johnson², and D. Oswald¹, ¹University of Illinois, Urbana, Illinois, ²H.K. Johnson Assoc. Industry Consultant, Chicago, Illinois.

An intercept survey of 218 lamb consumers was conducted to determine the receptiveness of targeted segments of the population to a branded

lamb alternative. The objective was to evaluate what characteristics these consumers would most value in a meat product and develop a profile for market segments where a branded product would have the most growth potential. This survey is in support of an overall project to create a model that can be franchised by livestock producers for developing and distributing a branded meat product. Lamb was selected as a test model, since the sheep industry presents the greatest challenges for recovery from a commodity-based industry to a customer driven industry.

The first step in developing a branded product is consumer feedback. Two greater Chicago area retail markets were targeted for determining preferences of current lamb consumers. Surveys were completed in the stores. Consumers were divided into three groups for analysis, Non-users, Light users (1 - 52 purchases per year), and Heavy users (greater than 52 purchases annually), which made up 10.1%, 75.2%, and 14.7% of the surveys respectively. Heavy users significantly reflect their ethnicity in dinner meals, with lamb in more than 40% of their meals. Light users averaged 20.7 lamb purchases per year, and were looking for improved price (62%), taste (51%) and less fat (49%) as important factors in increasing lamb purchases. Taste was the most important factor in all categories. Demographics showed no significant difference among the three user types. Consumers indicated that they would pay approximately 10% more for a consistently high quality product. The survey data indicated that the branded product should target the Light users, who makeup 75% of the individuals surveyed, and give the markets the highest potential sales increase of 32.7%.

Key Words: Consumer survey, Branded product, Lamb

72 Swine News - An information delivery tool for the pork industry. M.T. See*, North Carolina State University, Raleigh NC.

Swine News has been published as a monthly newsletter since 1978. The content and value of the newsletter were evaluated and new methods of delivery investigated. Swine News is available by mail through county offices, on the World Wide Web (WWW), and by internet broadcast subscription. As part of the monthly mailing (n = 2,165) a survey was administered resulting in a 3% response rate. Of the 67 respondents 97% read every issue. Respondents were pork producers (48%), university personnel (35%), allied industry (9%), state government (5%) and agricultural educators (3%). Most respondents resided in North Carolina (76%). Eighty-three percent of respondents rated Swine News as very informative or informative. On a 1 to 5 scale, with 1 as very informative, no response higher than a 3 was returned. How information needs are met was further analyzed with a statistical model that included reading frequency, occupation and state of residence. Reading frequency significantly (P = .08) influenced responses on how the newsletter met information needs. The average response from participants reading every issue was 1.67, while that from participants occasionally reading Swine News was 2.75. Occupation and state of residence were not significant (P > .6). Responses for topics of interest were evenly distributed with the most interest in waste management (21%) and the least interest in genetics (8%). This result indicates the importance of environmental issues to pork production. Topic responses also describe increased vertical integration of the pork industry where individual producer needs for nutrition and genetic information is reduced. Newsletter distribution over the WWW (<http://mark.asci.ncsu.edu>) averages 245 readers each month and provides an archive for the last four years. Swine News is also available by Internet broadcasting using Pointcast® technology. Broadcasting provides Swine News and other information directly to the subscribers (n = 80) computer. Swine News will continue to be provided in multiple formats with articles on a wide range of topics to support an audience with diverse interests.

Key Words: Pigs, Information, Education

73 Assessing Indiana pork producers media use and educational needs to remain viable in the swine industry. S. A. DeCamp*¹, B. T. Richert¹, B. A. Talbert¹, D. C. Kendall¹, K. A. Bowers¹, and G. Slipher², ¹Purdue University, West Lafayette, IN, ²Indiana Pork Producers, Indianapolis, IN.

A total of 1,442 questionnaires were sent to Indiana swine producers to assess educational needs and limitations to remain viable in the swine industry. Five hundred and fifty questionnaires were returned and resulted in an excellent distribution of producer size, age, operation type, and education level. Data were analyzed to determine associations between producer size (0-1000+ sows), age (16 to 82 years), operation type, and producer education level (no high school diploma to 4 year degree +) by educational programming parameters. Computers used for business increase as educational level and size increase (P<.003, P<.001). Producers are more willing to try video, CD-ROM, E-mail, and World Wide Web medias as education level increases (P<.01). As producer size increased, their willingness to try video conferencing and World

Wide Web increased (P<.002, P<.016). Producers with increased education are willing to travel more than 60 miles to educational programs as compared to less educated producers (P<.001). Producers ranked 8 areas of the swine industry based on educational need, the top three areas were environmental issues, financial management, and management and production basics. As size decreases the need for material developed on management and production basics and pork quality increases (P<.01, P<.001). When producer size increases the need for new and experienced employee training materials increases (P<.001). The three phases of production needing educational material were breeding, farrowing, and nursery. The three greatest challenges or risks to producer operations were environmental pressures, capital availability, and labor availability. The three limiting growth factors for producers are marketing, labor, and management practices. The order of producer's preference in educational program types were workshop, distance education, and seminar. Producer ranking of time to commit to educational programs was 2hrs., 4hrs., or learn at home their on own time. Results from this survey highlight many important areas for future extension educational programs concerning producer media usage and education content needed.

Key Words: Swine Producers, Extension, Educational Programs

75 Evaluating cost of treatment for bovine respiratory disease. R. Larson* and V. Pierce, University of Missouri, Columbia.

The objective of this study was to develop a tool that can be used to evaluate the economic effects of bovine respiratory disease (BRD) treatment regimen choices, and to use the tool to evaluate the sensitivity of production variables on dollars available for alternate BRD treatments. The tool estimates difference in return to ownership and management under a current treatment regime for BRD and an alternative regime with different case fatality rates. The tool was used to evaluate production scenarios with ranges of variable inputs. The most important variables for predicting dollars available for an alternate treatment were morbidity rate, sale price, and case fatality rate. Cost-of-gain was less important and purchase price was not an important consideration when evaluating BRD treatments. The sensitivity analysis shows that every 10% change in sale price, morbidity, or case fatality rate, results in approximately a 10% change in dollars available for BRD treatment. Moreover, while it is logical to recognize that case fatality rate for cattle treated with a given BRD treatment regimen has an important impact on dollars available for treatment; sale price, and morbidity rate have a similar impact on dollars available for BRD treatment. Therefore, in periods of high sale price or high morbidity, more dollars are available for BRD treatment than in periods of low sale price or low morbidity. High or low purchase price has little affect on dollars available for BRD treatment. High or low cost-of-gain has a moderate influence on dollars available for BRD treatment.

	\$ available: scenario with least \$ available	% change from %base scenario	\$ available: scenario with greatest \$ available	%change from %base scenario
Base scenario	\$0.243	-	\$17.40	-
Decrease purchase price 10%	\$0.243	0.04%	\$17.40	0.00%
Decrease Cost-of-Gain 10%	\$0.251	3.04%	\$17.58	1.08%
Increase sale price 10%	\$0.269	10.57%	\$19.04	9.43%
Increase morbidity 10%	\$0.267	9.95%	\$19.13	10.00%
Increase difference in CFR 10%	\$0.268	9.99%	\$19.13	10.00%

Key Words: Bovine respiratory disease, Treatment regimens, Economics

81 Characterizing the effects of changes for DHIA measures for profit changes in dairy herds. M. Lunak* and M. Faust, Iowa State University, Ames IA.

Objective for this study was to identify important effects of changes for performance measures for trends of profit score in dairy herds. Data were Dairy Herd Improvement records from 7 midwestern states for

1059 Holstein herds that had complete data for 5 consecutive yr (1992-1996). Initially, estimates of yearly change for individual herds were computed for performance measures and estimated profit score. Measures included: calving interval; first calving age; days dry; days in milk; rolling herd average (RHA); services per conception; days to first breeding; and percentages of cows bred > 3X, open > 120 d, in first lactation, dry > 70 d, dry < 40 d, with somatic cell counts > 400,000, and culled. Three data subsets were defined as herds with: 1) consistent increases, 2) consistent decreases, and 3) no consistent trend for profit score, and included 19, 36, and 1004 herds, respectively. Simple regression analyses were used to determine associations of changes for individual performance measures on changes for profit scores for each data subset. Means for change of profit score in herds with no trend and consistent increases and decreases for annual profits were \$3.16, \$141.0, and \$ -164.27 per cow, respectively. For herds with consistent profit score increases, important effects of changes (*italicize* $P < .05$) for score were calving interval, days dry, first calving age, and services per conception, and these performance changes influenced trends for score by \$-0.04, \$1.5, \$3.82, and \$36.5, respectively. For herds with consistent decreases for profit, changes in cull percent and RHA were important indicators of change for score (\$-7.42 and \$-0.2, respectively). Important effects of changes for profit score in herds with no profit trends were first calving age; services per conception; days dry; and percent cows bred > 3X, and with > 400,000 somatic cells (\$-24.6, \$56.16, \$-2.9, \$2.24, and \$-3.1 respectively). For consistently profitable herds, reproductive measures impacted profit score, however yield and cull measures were most important for profitability in herds with consistently decreasing profits.

Key Words: Profitability, Reproductive-traits, Dairy-performance

82 Growth response and carcass characteristics of yearling steers utilizing different implant strategies. G.D. Fike^{*01}, D.L. DeWitt⁰¹, and J. Illg^{02, 01} *Iowa State University, Ames, Iowa, 02Humboldt Veterinary Clinic, Humboldt, Iowa.*

A demonstration to determine the effects of early or late administration of trenbolone acetate (TBA) in combination with estradiol on feedlot performance and carcass response in yearling steers was conducted at the Allee Demonstration Farm at Newell, Iowa. Seventy-five steers (weight = 388 kg) were allotted to one of three groups: 1) 120 mg TBA + 24 mg estradiol (n = 25; single implant = SI) on day 0, or 2) 100 mg progesterone + 10 mg estradiol benzoate on d 0 followed by 120 mg TBA + 24 mg estradiol implant on d 56 (n = 25; double implant = DI). The control group (n = 25) received no implant. The steers were weighed every 28 d and ultrasound data were collected until harvest on d 106 when actual carcass data were collected. SI steers had greater ($P < .05$) ADG than both DI and control steers on d 28 (1.53, 1.01, and 1.12 kg/d, respectively) and also at d 56 (1.98, 1.69, and 1.61 kg/d, respectively). In the 28 d period following their second implant, DI steers gained more rapidly ($P < .05$) than SI or control steers (2.20, 1.75, and 1.81 kg/d, respectively). SI and DI steers had greater ($P < .05$) ADG (1.63 kg/d and 1.56 kg/d respectively), than controls (1.32 kg/d) during the entire demonstration. SI steers tended ($P = .08$) to have more efficient DM conversions than control steers (7.35 kg DM/kg gain vs. 8.35 kg DM/kg gain). SI and DI steers had heavier carcass weights ($P < .05$) than controls by 16.8 kg and 11.4 kg, respectively, and also had greater ($P < .05$) rib eye areas of 31.8 cm² and 32.0 cm² compared to 30.3 cm² for control steers. Marbling scores were higher ($P < .05$) for DI steers (1028; 1000 = Choice - and 900 = Select -) than controls but did not differ from SI steers (1016). There were no differences in fat thickness at the 12th/13th rib, yield grades, or dressing percent among groups. Implanted steers exhibited improved feedlot performance and carcass characteristics compared with controls, but timing of TBA administration had no effect on aggregate performance in implanted steers.

Key Words: steers, implant, trenbolone acetate

83 Grazing and finishing performance and carcass characteristics of steers fed Arsoy (high protein) supplements during late-summer grazing. J. F. Gleghorn^{*}, T. T. Marston, and D. O. Yauk, *Kansas State University, Manhattan.*

Crossbred steers (n = 149) grazing late-summer pastures were used to evaluate the effects of feeding Arsoy as a protein supplement in a two-year grazing trial. Steers (initial wt = 230 ± 15 kg) were randomly assigned to native grass pastures and treatments were randomly assigned to pastures for year 1. Treatments were rotated between pastures in year 2 to reduce pasture effect. Treatments consisted of: CONTROL, no protein supplement; and ARSOY, a protein (CP=33%) supplement fed daily at 1.45kg/hd. Cattle were weighed and supplementation began in mid to late July and ended in early October each year. Steers were transported to a commercial feeding facility and placed into a common drylot pen at the conclusion of the grazing period. Steers were fed step-up and finishing diets until the average of the pen was deemed ready for slaughter (approximately 10 mm backfat, adequate days on feed to grade low Choice, with a minimum of 150 days on feed). Slaughter weight was calculated by dividing hot carcass weight by the average dressing percentage of the pen. Other carcass measurements were obtained following a 24-hour chill. ARSOY supplementation resulted in an average pasture gain advantage of 24.0 kg ($P < .01$). Added gain to supplemental intake ratio was .177:1. No gain difference was noted between CONTROL (1.26 kg/d) and ARSOY (1.24 kg/d) treated steers during the finishing phase ($P > .21$). The ARSOY-fed steers were able to maintain approximately 82% of their pasture weight gain advantage through the finishing phase ($P < .01$). Hot carcass weight was greater for ARSOY than CONTROL steers ($P < .01$). Marbling score, percentage of USDA Choice carcasses, KPH fat, and ribeye area were not influenced by late-summer supplementation ($P > .19$). These data conclude that the addition of ARSOY as a supplement can increase weight gains accrued during the grazing phase of commercial beef production without compromising feedlot performance and carcass characteristics.

Key Words: Beef cattle, Protein supplementation, Soybean by-product

84 Teaching skills in farrowing management by distance education. D. E. Reese¹, L. J. Johnston², K. J. Stalder^{*3}, W. L. Singleton⁴, J. Felt⁵, and K. B. Kephart⁶, ¹University of Nebraska, Lincoln, ²University of Minnesota, Morris, ³University of Tennessee, Knoxville, ⁴Purdue University, West Lafayette, IN, ⁵National Pork Producers Council, Clive, IA.

There is steady demand for workers well-trained in specialized pork production. However, these workers have limited time or desire to attend traditional training. With this in mind, swine specialists from 10 universities cooperated with NPPC to develop and deliver a self-paced course on farrowing management via the Internet and correspondence through the U.S. mail. Course contents were organized into 10 lessons, each one with a quiz. A total of 142 people (99 Internet, 43 correspondence) from 28 states and 8 foreign countries enrolled in the course. Sixty-four (40 Internet and 24 correspondence) participants completed a course evaluation. Most (89%) survey respondents indicated that they had not enrolled in a distance education course previously. Over 67% of the respondents were either an owner/operator, a farrowing area manager, or an employee of a pork production unit. Forty-six and 42 percent of the survey respondents had over 8 years and less than 4 years of farrowing experience, respectively. Most indicated that the best time to complete their study was before 800 h (11%) and after 1700 h (48%). Over 90% of the respondents indicated that 15 hours or less were required to complete the course. As a result of the course, 80% of the survey respondents said that they were planning to make changes in how work was performed in the farrowing area of their operation. Ninety-eight percent of the respondents said that the course provided them with an opportunity to improve their job skills and 97% indicated that they would be interested in taking additional distance education courses. The course benefitted people regardless of prior work experience in farrowing and it offered them a means of improving job skills in a reasonable time frame while maintaining a normal work schedule.

Key Words: Distance education

85 Manure nutrient analysis of Kansas swine lagoons. J. M. DeRouchey^{*1}, R. D. Goodband¹, J. L. Nelssen¹, M. D. Tokach¹, G. L. Keeler², and S. S. Dritz¹, ¹*Kansas State University, Manhattan*, ²*Kansas Department of Agriculture, Topeka*.

New Kansas laws require producers to file nutrient management plans using either analyzed nutrient composition of manure or a series of default values. This project was conducted to determine the accuracy of the default values for Kansas. Analyses of 41 manure samples were used to determine the mean and standard deviation of nutrient concentrations from Kansas swine lagoons. Manure samples were collected by the individual operations for chemical analysis in compliance with Kansas waste management plans. Therefore, sampling technique, time of year, type of lagoon, sample handling prior to analysis, type of production system, and laboratory used were not controlled among operations participating in the survey. For ammonium N (N which is available to plants during the growing season), Kansas lagoon concentrations were 709 ± 398 ppm. The amount of organic N (N that is slowly released from the manure into

the soil) was 190 ± 209 ppm. In addition, the amount of N in nitrate form was less than 1 ppm. Total N in the manure (sum of ammonium N, organic N, and nitrate N) was 899 ± 584 ppm. Noticeably high SDs indicates considerable variation between swine lagoons. Values for N for lagoons in this study were higher than previously reported from sources in other states. Level of P_2O_5 was 371 ± 549 ppm, which was lower than formerly reported values. Potash (K_2O) levels were double of previous reported concentrations at $1,043 \pm 617$ ppm. Mean concentrations for K, S, Ca, and Mg were 847, 44, 154, and 60 ppm with SDs of 519, 43, 85, and 82 ppm, respectively. For microminerals, Zn and Cu had mean concentrations of 6.2 and 1.6 ppm with SD of 8.9 and 2.3 ppm, respectively. Finally, Mn and Fe had average concentrations of 2 and 19 ppm, with SDs of 2.9 and 25.4 ppm. Results from this survey revealed that mean nutrient concentrations from lagoons vary considerably, and that most producers will benefit by chemically analyzing their manure rather than using reference values in crop utilization plans.

Key Words: Swine Lagoons, Manure, Environment

GROWTH, DEVELOPMENT, MUSCLE BIOLOGY AND MEAT SCIENCE

90 Evaluation of short-term supplementation of creatine monohydrate and alpha-lipoic acid as a means to improve fresh pork quality. Eric Berg^{*}, Mike Linville, and Gary Allee, *University of Missouri-Columbia*.

The objectives of this study were to determine if short-term supplementation of creatine monohydrate (CMH) and α -lipoic acid (LA) improved the fresh pork quality characteristics of color, pH, purge loss, and Warner/Bratzler (WB) shear force. Forty-eight commercial hybrid barrows were blocked by BW prior to test and randomly allotted to supplementation of 24g CMH/pig/day, 600mg LA/pig/day, combined CMH and LA, or no CMH or LA for five days prior to slaughter. Twelve pigs per treatment were individually penned with ad libitum access to water and finishing ration. Treatments were given orally in divided doses at 0600, 1200, and 1800 hours. Pigs were harvested at 113 Kgs BW in two groups of 24. Intramuscular pH was recorded with a PH-Star probe (SFK Tech., Inc) at 45-min postmortem (PH1) and again at 24-h (PH24) in the ham semimembranosus (SM) and loin muscle between the 10th and 11th rib (LM). A MeatcheckTM conductivity probe (SFK Tech., Inc) was used in the same locations. The MeatcheckTM index (PY) is a value from 0 and 100 with the higher value indicating higher water-holding capacity. Color (L^* , a^* , b^*) was obtained with a Hunter-Lab MiniScan XE (D65/10°) at 24-h postmortem on the ham gluteus medius (GM), SM, and LM. One, 2.54-cm thick loin chop was removed from the loin for determination of WB shear. The intact SM and the posterior portion of the boneless loin was vacuum packaged and stored for 7 days to determine purge loss. A 2 x 2 x 2 factorial design was used to test the fixed effects of slaughter day, CMH, LA, and interactions. Lipoic acid had a positive effect on pork quality as loin PH1 (6.48 vs. 6.04) and LM L^* -value (52.9 vs. 49.3) were significantly ($P < .05$) higher and lower than controls. Ham SM L^* -values tended to be darker than controls after 7-d aging (45.9 vs. 47.2; $P = .0733$). Combined CMH and LA appeared to be deleterious to quality. Lipoic 24-h loin pH (5.35 vs. 5.29; $P = .09$) and PY (40.3 vs. 30.7; $P = .08$) tended to be higher than CMH*LA, while GM L^* -value (45.5 vs. 47.7; $P = .07$) was lower. Cook loss was significantly ($P < .05$) lower for LIP (27.9%) vs. CMH*LIP (32.1%). Although not statistically different, purge loss from LIP loin (3.32%) and SM (2.72%) was lower than CMH*LIP loin (4.33%) and SM (3.62%).

Key Words: Pork Quality, Creatine Monohydrate, Lipoic Acid

91 Warming chilled, normal-pH pork to body temperature duplicates the pale, soft, and exudative condition demonstrating pH and temperature interaction in PSE development. K. Freise ^{*}, S. Brewer, and J. Novakofski, *University of Illinois*.

The objective of this experiment was to duplicate conditions within muscle that are thought to cause the pale, soft, and exudative (PSE) condition in post-mortem pork. Controlled duplication of these conditions would allow us to clearly demonstrate the role of pH and time at a post-mortem body temperature in a laboratory model system or

a classroom situation. Our approach was to determine whether "normal" colored, textured, and fluid holding capacity pork chops could be made PSE by warming them at or just above post mortem body temperature. Heating time and initial pH were measured to determine their combined and independent effects on color and fluid holding capacity of the meat. Each replicate consisted of six 1.2 cm chops cut sequentially from the same loin. Initial pH and weight were measured, then they were vacuum-sealed and kept on ice overnight to allow color to equilibrate. Reflectivity was measured using Hunter Lab MiniScan XE and Minolta Chroma Meter CR-300 colorimeters through the vacuum sealed bags. Five chops were heated in an approximately 42°C water bath for 15, 30, 60, 120, and 240 min, one control was kept on ice. Chops were immediately placed in a 10 min ice bath at the end of their heating periods. Colorimeter values were again taken while vacuum-sealed. Chops were removed from their bags and reweighed. The difference between initial and final weights was used to calculate the percent purge. The pH was measured again and chops were allowed to bloom for 30 min in a cooler, then colorimeter values were re-measured and color was visually assessed. Our results showed that warming normal-pH pork chops to post-mortem body temperature increased purge over time ($p \leq 0.001$) and lightness as indicated by the L^* values ($p \leq 0.001$). The relationship of initial pH to lightness change ($p \leq 0.001$) and purge change ($p \leq 0.001$) was also highly significant. These results clearly demonstrate the importance of high temperature at normal post mortem pH in development of PSE condition. These results would be useful in modeling PSE change in muscle protein to develop an understanding of additional factors relevant to pork quality determination. In future experiments we plan to determine the effect of temperatures at and below body temperatures in duplication of PSE characteristics during carcass cooling.

Key Words: PSE pork, in vitro modeling, temperature

92 Comparison of ham separation techniques. D.W. Newcom^{*1}, T.J. Baas¹, R.N. Goodwin², and P. Chen¹, ¹*Iowa State University*, ²*National Pork Producers Council*.

The objective of this study was to evaluate the two dissection techniques used on fresh hams obtained from the National Pork Producers Council's Quality Lean Growth Modeling Project. Growth, carcass, and muscle quality data were collected from 1552 pigs (over three replicates) from six genetic lines representing an equal number of barrows and gilts. Pigs were tested at the Minnesota Swine Testing Station in New Ulm, Minnesota and randomly assigned to one of four diets and one of three slaughter weights: 113.6, 131.8, and 150 kg. All hams were collected twenty-four hours post-mortem. The left side of each carcass ($N=696$) was packaged and shipped to Geneva Meats (Geneva, MN) for carcass separation. The hams were cut from the carcass side, weighed, and skinned in preparation for dissection. Hams were physically separated into soft tissue components of inside and outside ham and knuckle (including seam fat), external and intermuscular "star" fat, and bone. The ham from the right side of each carcass was packaged and shipped to Texas A&M University Meat Lab in College Station, TX. The hams were then separated into knife separable lean which included inside ham (semimembranosus), outside ham (biceps femoris and semitendinosus), knuckle (quadriceps group), skin, bone, subcutaneous fat, and seam fat.

Individual pig differences were calculated between the left and right side for total ham weight, total fat (subcutaneous and seam), total muscle (inside and outside ham, knuckle, and other soft tissue), bone, and skin. These variables were evaluated with a general linear model that included the fixed effects of genetic type, sex, diet, and slaughter date with off test weight as a covariate. The effect of genetic type on skin weight differences was significant ($P < .05$). Other variables tested were non-significant for all remaining main effects ($P > .05$). Based on these results, differences in the ham weight components between the two separation techniques were small.

Key Words: Pigs, Ham

93 Consumer visual preferences of marbling and color of fresh beef steaks. K.M. Killinger*, C.R. Calkins, W.J. Umberger, D.M. Feuz, and K.M. Eskridge, *University of Nebraska, Lincoln*.

Consumers in the Chicago area visually evaluated two pairs of steaks in order to determine preference and value associated with differences in marbling and color. New York strip steaks that differed in marbling level (modest or better versus slight) or color (dark cutting versus bright cherry-red ribeye steaks) were presented as pairs in a refrigerated retail display case. Twelve groups of 6-12 consumers each were asked to record the price that they were willing to pay for each steak and to indicate the steak in each pair they would purchase if shopping in a retail store. Price data for each pair were analyzed as a split plot with preference for marbling (high or low) or color (normal or dark) as the whole plot and steak trait (high versus low marbled or dark versus normal color) as the split plot. Most consumers (104 of 123) preferred low-marbled steaks and were willing to pay a premium of \$1.07 per pound over high-marbled steaks (\$4.27 versus \$3.10 per pound, respectively, $P = .0001$). Those who preferred high-marbled steaks ($n = 19$) were willing to pay a much smaller premium (\$3.93 versus \$3.45 per pound, respectively, $P = .34$). About two-thirds of the participants (85 of 124) preferred normal color and were willing to pay a small but significant premium of \$.51 per pound (\$3.73 versus \$3.22, respectively, $P = .02$). Those with a preference for darker color were willing to pay about the same premium for their preferred cut (\$3.47 versus \$3.01, respectively) but this difference was not consistent enough to be significant ($P = .14$). These data indicate that most consumers prefer steaks with a slight amount of marbling, and are more passionate in their preference (based on price) than those who prefer higher amounts of marbling (modest or greater). The majority of consumers do not like steaks with dark color.

Key Words: Consumer Preferences, Marbling, Beef Color

94 Effects of quality grade, postmortem age, blade tenderization, and endpoint cooking temperature on Warner-Bratzler shear force and sensory panel evaluation of beef longissimus steaks. C. D. George-Evins, J. A. Unruh*, J. L. Marsden, and C. L. Kastner, *Kansas State University, Manhattan*.

Strip loins ($n = 162$) were used to determine the influence of quality grade (Select, SEL; Choice, CHO; and Certified Angus BeefTM, CAB), aging period (7, 14, or 21 d), blade tenderization passes (zero, 0X; one, 1X; or two, 2X times), and endpoint cooking temperature (65.5, 71, or 76.6°C) on longissimus steak tenderness. Warner-Bratzler shear (WBS) evaluations were conducted on all treatment combinations and sensory panel evaluations were conducted on CHO steaks cooked to 71°C. With each increase in endpoint cooking temperature, cooking loss and WBS increased ($P < .05$). For steaks aged 7 d, all quality grade and blade tenderization treatments had similar ($P > .05$) WBS. For steaks aged 14 d, CHO steaks had lower ($P < .05$) WBS than SEL steaks, CAB steaks tended ($P = .07$) to have lower WBS than SEL steaks, 2X steaks had lower ($P < .05$) WBS than 1X steaks, and 1X steaks had lower ($P < .05$) WBS than 0X steaks. For steaks aged 21 d, CAB steaks had lower ($P < .05$) WBS than CHO steaks, CHO steaks had lower ($P < .05$) WBS than SEL steaks, and 2X steaks had lower ($P < .05$) WBS than 1X steaks. For steaks blade tenderized 0X and 2X, CAB and CHO steaks had lower ($P < .05$) WBS than SEL steaks. For steaks blade tenderized 1X, only CAB steaks had lower ($P < .05$) WBS than SEL steaks. For steaks aged 7 d, steaks blade tenderized 1X and 2X had higher (more tender, $P < .05$) ratings for myofibrillar and overall tenderness than 0X steaks. For steaks aged 14 d and 21d, 2X steaks had higher ($P < .05$) ratings for myofibrillar and overall tenderness than 0X and 1X steaks. For steaks aged 21 d, 2X steaks had less detectable connective tissue ($P < .05$) than 0X and 1X. Blade tenderization is a useful technology for improving tenderness of strip steaks, but should be combined with high

quality grades, postmortem aging, and lower endpoint temperatures to achieve maximum tenderness.

Key Words: Beef, Tenderness, Blade tenderization

95 The impact of fertilization with poultry litter on microbial contamination of grass-fed beef Carcasses. J. R. Davis*, J. K. Apple, D. H. Hellwig, E. B. Kegley, and F. W. Pohlman, *University of Arkansas, Fayetteville*.

Recent reports have questioned the microbiological safety of feeding stacked poultry litter directly to beef cattle; however, little information exists concerning the indirect consumption of raw litter on microbial contamination of beef carcasses. Therefore, 32 mature beef cows were used to examine the impact of fertilizing pastures with poultry litter on the incidence of Salmonella (S) and Escherichia coli O157:H7 (Ec) on carcasses, trimmings, and ground beef. Approximately 19.7 metric tons of broiler litter were purchased and surface applied to four .445-hectare pastures at a rate of 4.48 metric tons/hectare. Litter samples were taken during application and cultured for presence of S and Ec. No raw litter samples were culture-positive for S or Ec. Cows were blocked by weight and assigned randomly to graze either on 1 of 4 pastures fertilized with a commercially-available fertilizer, or 1 of 4 pastures fertilized with broiler litter. Fecal samples were taken at 7-d intervals for 2 weeks prior to introduction to pastures and on the d prior to harvest. One cow/pasture was chosen randomly for harvest after 4, 9, 19, and 39 d of grazing. Upon harvest, the left side of each carcass received a 2% lactic acid rinse, and neck and bung incision samples were taken from both sides of each carcass. Trimmings from both sides were removed, packaged separately, and refrigerated for 6 d at 2°C. After samples of purge were collected, trimmings were ground, and random ground beef samples were collected. All fecal, neck and bung incision, purge, and ground beef samples were analyzed for presence of S and Ec immediately after collection. No S or Ec were detected ($P > .10$) in any samples, and no difference ($P > .10$) was observed for carcasses with or without lactic acid rinse for S and Ec. These data suggest that cattle can graze pastures freshly fertilized with raw poultry litter without an increased risk of beef carcass contamination with S or Ec.

Key Words: Poultry litter, Beef carcasses, Microbial contamination

96 The impact of feeding poultry litter on microbial contamination of beef carcasses. J. R. Davis*, J. K. Apple, D. H. Hellwig, E. B. Kegley, and F. W. Pohlman, *University of Arkansas, Fayetteville*.

Mature beef cows ($n = 32$) were used to examine the impact of feeding a high level of poultry litter to beef cattle on the incidence of Salmonella (S) and Escherichia coli O157:H7 (Ec) on beef carcasses, trimmings, and ground beef. Cloacal swabs from 50 randomly selected birds and floor drag-swabs taken immediately before bird removal from the broiler house were cultured for presence of S and Ec. Neither cloacal swabs or floor drag-swabs were culture-positive for S or Ec. Following bird removal, approximately 13.6 metric tons of broiler litter were removed and deep-stacked to a depth of 1.5 m for 21 d, reaching an internal temperature of 59°C. Cows were blocked by weight and assigned randomly either ad libitum access to grass hay, or ad libitum access to a treatment diet of 80% deep-stacked poultry litter:20% corn (as fed basis) and .91 kg long-stemmed grass hay (as fed basis). Diets were approximately equal in TDN and adequate in CP and mineral content. Fecal samples were taken at 7-d intervals for 2 weeks prior to and 8 weeks following introduction of dietary treatments. After 56 d on treatments, cattle were humanely harvested following industry-accepted procedures. Left sides of each carcass received a 2% lactic acid rinse, and neck and bung incision samples were taken from both sides of each carcass. Trimmings from both sides of each carcass were removed, packaged separately, and refrigerated for 6 d at 2°C. After samples of purge were collected, trimmings were ground, and random ground beef grab samples were taken. All fecal, neck and bung incision, purge, and ground beef samples were analyzed for presence of S and Ec immediately after sampling. No S or Ec were detected ($P > .10$) in any samples, and no difference ($P > .10$) was observed for carcasses with or without lactic acid rinse for S and Ec. These results suggest that deep-stacked poultry litter can be fed to beef cattle without increasing the risk of beef carcass contamination with S or Ec.

Key Words: Poultry litter, Beef carcasses, Microbial contamination

97 Reduction of microbial pathogens in ground beef using multiple intervention technology. M. R. Stivarius*, F. W. Pohlman, K. S. McElyea, M. G. Johnson, J. K. Apple, A. L. Waldroup, and Z. B. Johnson, *University of Arkansas, Fayetteville.*

The purpose of this study was to utilize multiple antimicrobial interventions in a ground beef system to reduce the microbial load through simulated retail storage. Frozen beef trim was thawed to 4°C and inoculated with a mixture (7.0 log CFU/ml) of *E. coli* (ATCC 11775; EC) and *Salmonella typhimurium* (nalidixic acid resistant; ST). Treatments consisting of 5% acetic acid followed by .5% cetylpyridinium chloride (AC), 200 ppm chlorine dioxide followed by .5% cetylpyridinium chloride (CC), .5% cetylpyridinium chloride followed by 10% trisodium phosphate (CT), or untreated control (C) were tested. After treatment, beef trimmings were then ground twice, placed in foam trays on absorbent diapers, and overwrapped with polyvinyl chloride film. Packages were stored at 4°C under simulated retail lighting (deluxe warm white light: 1630 lx) and evaluated for aerobic plate count (APC), coliform (CO), EC, ST, instrumental color, and sensory color and odor characteristics on d 0, 1, 2, 3 and 7 of storage. The AC, CC and CT treatments reduced ($P < .05$) ST by 2.0, 1.4 and 1.2 log CFU/g, and APC by 1.8, 1.2 and 0.9 log CFU/g, respectively, compared with C. Likewise, by d 7, the AC, CC and CT treatments reduced ($P < .05$) EC by 2.0, 2.6 and 1.1 log CFU/g, and CO by 2.7, 2.5 and 1.0 log CFU/g, respectively, compared to C. The CT treatment maintained ($P < .05$) a redder (larger a^* value and 630:580 nm) color by d 7 of storage compared to C; however, the L^* was significantly ($P < .05$) lower (darker) than C by d 7 of storage. Sensory panelists were able to detect ($P < .05$) less beef odor and greater off odor intensities for the AC treatment compared to C through 7 d of storage. Sensory panelists also indicated that the CT treatment maintained a brighter red ($P < .05$) overall color and lower ($P < .05$) percentage discoloration than C through 7 d of storage. Beef odor and off odor intensity characteristics were not different ($P > .05$) between C, CC and CT treatments through 7 d of storage. The results of this study indicate that the use of multiple interventions can be effective for improving both the safety and quality of ground beef.

Key Words: *E. coli*, Salmonella, Ground beef

98 Increased uncoupling protein-1 (UCP-1) mRNA in mice selected for low heat loss versus high heat loss. T. G. McDanel* and J. L. Miner, *University of Nebraska.*

Uncoupling protein-1 (UCP-1) is a mitochondrial protein located in brown adipose tissue (BAT). Uncoupling protein-1 mediates nonshivering thermogenesis through dissipation of the proton gradient, producing heat instead of ATP. An experiment was conducted to determine UCP-1 expression in mice selected for high (MH) or low (ML) heat loss. A randomly selected control line (MC) was also analyzed. We hypothesized that the MH line would have more UCP-1 mRNA than the ML line. Two experiments were conducted. In experiment 1, 12 12-wk-old males from each line housed in shoebox cages at 22°C and fed standard chow ad libitum were sacrificed. Brown adipose tissue was immediately obtained and total RNA was extracted. Ribonuclease protection assay was used to quantify UCP-1 and β -actin mRNA. The UCP-1 riboprobe was antisense to mouse UCP-1 (559-735) and was labeled with 32 P by in vitro transcription. Following hybridization and digestion as adapted from Ambion, protected probe was separated by PAGE and quantified using a phosphorimaging device. The ML mice had 49% greater UCP-1 mRNA than MH mice ($P < 0.05$) and 11% greater than MC mice ($P < 0.6$) when not corrected for actin. Correction for actin resulted in no difference in UCP-1 mRNA between lines. In experiment two, eight males from each line (MH and ML) were evaluated for UCP-1 mRNA levels in BAT at 12 wk of age. The ML mice exhibited 130% greater UCP-1 mRNA than MH mice ($P < 0.06$), regardless of correction for actin. The concentration of UCP-1 mRNA was 188 and 81.9 amol/ μ g total BAT RNA for ML and MH mice, respectively (SE=36.3; $P < 0.06$). We therefore reject our hypothesis and conclude that UCP-1 content of BAT is not greater in MH than in ML mice.

Key Words: Uncoupling protein, Energetics, Obesity

99 Monitoring bone metabolism in growing horses and turkeys. J.N. Hawkins*, K.J. Lang, K.L. Waite, T.L. Peters, B.D. Nielsen, K.D. Roberson, and M.W. Orth, *Michigan State University, East Lansing, MI.*

Bone turnover can be assessed by measuring serum levels of molecules specific to bone formation and resorption. Osteoblasts synthesize osteocalcin (OC), a noncollagenous protein, which interacts with the inorganic matrix. A small fraction of OC is released into circulation and has been correlated with bone formation. Osteoclasts degrade collagen and release pyridinoline (Pyd), a nonreducible crosslink that stabilizes collagen chains, during bone matrix degradation. Thus, serum Pyd levels are indicative of bone resorption. Serum markers have been used extensively to monitor skeletal metabolism in humans. The purpose of our study was to use OC and Pyd to monitor skeletal metabolism in developing livestock. In this study, serum OC and Pyd were measured in Arabian horses ($n=9$) at 0, 15, 30, 45, 60, 90, 120, and 150 days of age and in Nicholas male turkeys ($n=6$) at 3, 6, 9, 12, and 15 weeks of age using ELISA kits from Metra BiosystemsTM. Statistical analysis of data was performed by SAS using least squares means. In horses, serum OC levels increased by 1.5-fold from day 0 to days 15, 30, and 45 ($p < 0.01$). Serum Pyd levels declined from day 0 by 2.6-fold when compared to other days ($p < 0.01$). In turkeys, no significant change was observed in OC levels for 9 weeks; however, OC increased in weeks 12 compared to weeks 3 and 9 ($p < 0.04$). Serum Pyd levels did not change until weeks 12 and 15 in which levels increased 1.4-fold in comparison to weeks 3, 6 and 9 ($p < 0.01$). These data suggest that horses have a higher bone turnover rate immediately following birth. In contrast, serum OC and Pyd levels were lower in turkeys at an earlier age and greatly increased at 12 weeks of age. Pyd crosslink formation occurs during the final stage of collagen maturation. Turkeys may have lower Pyd levels at a young age due to rapid bone growth and insufficient time for maturation of collagen and crosslink formation. Turkeys reach market age at 20 weeks, whereas horses will not reach skeletal maturity until 2-3 years of age. Thus, a contrasting pattern for bone turnover reflects the varying growth rates in horses and turkeys.

Key Words: Bone, Horses, Turkeys

100 Porcine agouti-related peptide: cloning, tissue distribution, and quantitation of size-related differences in gene expression. C.J. Dyer*¹, K.J. Touchette², G.L. Allee², J.A. Carroll¹, and R.L. Matteri¹, ¹USDA-ARS Animal Physiology Unit, Columbia, MO, ²University of Missouri, Columbia, MO.

Agouti-related peptide (AGRP) is a 131 amino acid peptide produced in the hypothalamus and other tissues. AGRP stimulates appetite in rodents when administered centrally, and acts as a melanocortin receptor antagonist, blocking the appetite-suppressing activity of α -MSH. A 226 bp cDNA was generated from porcine hypothalamic RNA by use of a reverse transcription-polymerase chain reaction (RT-PCR) and primers designed from the published human AGRP cDNA sequence. This PCR fragment was then cloned into a vector and sequenced. The confirmed porcine AGRP cDNA sequence was found to be 84% homologous to the corresponding human sequence. An AGRP cRNA probe was transcribed from this clone and used to examine AGRP expression in several porcine tissues via RT-PCR followed by Southern hybridization. Although the hypothalamus was found to be the major site of AGRP gene expression, several other tissues expressed AGRP mRNA as well, including anterior pituitary, thymus, testis, adrenal and liver. A larger (650 bp) PCR fragment was found to hybridize to the porcine AGRP cRNA in spleen, adrenal, and liver tissues; this fragment was cloned and sequenced and found to be an AGRP cDNA which contains intron III, indicating the possibility of splice variants existing in these tissues. Next, hybridization assays were performed to quantitate differences in hypothalamic AGRP gene expression in large (5.098 \pm .093 kg, $n=11$) and small (3.966 \pm .073 kg, $n = 12$) 14d old weanling piglets. Large piglets expressed greater amounts of AGRP mRNA than did small piglets as measured in relative densitometric units after normalization to 18S ribosomal RNA (1.382 \pm .059 vs. 0.912 \pm .084, $P = 0.002$). These data represent the first characterizations of AGRP gene expression in a livestock species. Future studies will assess the role of AGRP in appetite stimulation and animal growth.

Key Words: Appetite, Swine, Agouti-related peptide

101 Porcine melanin-concentrating hormone (MCH): cDNA sequence, tissue distribution of mRNA, and effect of weaning and piglet size on hypothalamic gene expression. R.L. Matteri^{*1}, C.J. Dyer¹, K.J. Touchette², J.A. Carroll¹, and G.L. Allee², ¹USDA-ARS Animal Physiology Unit, Columbia, MO, ²University of Missouri, Columbia, MO.

Melanin-concentrating hormone stimulates feeding when administered to rats and is highly expressed in ob/ob mice. The purpose of this study was to clone the coding region of the mature porcine MCH peptide, screen various tissues for the presence of MCH mRNA, and evaluate MCH gene expression in newly weaned vs. unweaned pigs. PCR primers based upon known cDNA sequences in rodents and man were designed and utilized for RT-PCR amplification of a 272 bp DNA from porcine hypothalamic RNA. The resulting PCR product was subcloned into the pGEM-T easy vector (Promega, Madison, WI). The identity of the clone was verified by dideoxy termination sequencing and found to be 94% homologous with the human sequence. Pooled RNAs were prepared from hypothalamus, pituitary, fat, muscle, liver, spleen, thymus, adrenal and testis (3-4 piglets/tissue pool). Analysis by RT-PCR revealed detectable MCH expression only in the hypothalamus. Fourteen-day-old nursing pigs were either kept with their sow or weaned onto starter diets containing 0 or 7% plasma protein (n=8/group). Piglets were further allocated by size into small (3.5-4.3 kg) and large (4.6-5.7 kg) groups. Piglets were sacrificed 4 days later for tissue collection. Hypothalamic MCH mRNA levels (relative to 28S rRNA) were evaluated by slot-blot hybridization. Levels of hypothalamic MCH mRNA did not differ among weaning groups (P = .7), but tended to be higher in the large piglets (P = .058). Hypothalamic MCH mRNA levels were positively correlated with serum insulin concentrations (P = .04) and levels of hypothalamic mRNAs for neuropeptide Y, orexin and agouti-related protein (P < .002), but not with leptin receptor mRNA (P = .15). Levels of MCH and adipose leptin mRNAs were inversely related (P = .05). The present results are consistent with a responsiveness of MCH to peripheral and central endocrine/neuroendocrine signals of nutritional status and appetite.

Key Words: Appetite, Piglet, MCH

102 Growth response by high and low lean growth capacity pigs to immune system stress. R. D. Boyd^{*1}, M. A. Mellencamp¹, M. E. Johnston¹, M. E. White², T. Molitor², K. L. Houseknecht³, and E. R. Wilson¹, ¹PIC USA, Inc., Franklin, KY, ²University of Minnesota, Saint Paul, MN, ³Purdue University, West Lafayette, IN.

A total of 132 pigs were used to test for genetic differences in response to immune system stress. Pigs were derived from C22 females bred to a high (PIC337) or low (PIC14) lean growth (LG) capacity line. Treatments (TRT) involved i.m. injections of Control (PBS) or bacterial endotoxin solutions (LPS, lipopolysaccharide). Forty-eight pigs were allocated to each TRT at 65 ± 2 kg BW, penned as pairs and used for a growth assay. Thirty-six additional pigs were similarly allocated, but penned individually to document acute feed intake (FI) and physiological response. Pigs received serial injections of LPS or Control buffer at 7 day intervals for 28 days with initial LPS dose (15 µg/kg BW) increased by 50% each 7 days. Acute LPS challenges reduced FI 24 hour post-injection by approximately 50% (P<.01) and ADFI for the 28 day test by 7.2% (P<.05). LPS recipients tended to grow slower (-5.8%) but this was not significant (P<.18). Lines responded similarly for ADG and ADFI. Feed efficiency (G:F) tended to improve for low LG pigs (+.016 units) and decline for high LG pigs (-.004 units) but a line x TRT effect was not significant at either 14 (P<.18) or 28 days (P<.28). Serial acute challenges with LPS depressed FI, ADG, and G:F ratio but a more rigorous (and chronic) challenge is needed to test genetic x environmental interactions.

TRT	Line	ADFI, kg/d	ADG, g/d	G:F
Control	14	2.95	900	.306
LPS	14	2.68	860	.322
Control	337	2.92	959	.327
LPS	337	2.77	892	.323
SEM	-	.10	39	.009

Key Words: Growing pigs, Immune stress, LPS

103 Conjugated linoleic acid improves feed efficiency, decreases backfat and improves pork quality attributes. B.R. Wiegand^{*}, J.E. Swan, S.T. Larsen, F.C. Parrish, Jr., and T.J. Baas, Iowa State University Ames, IA.

Conjugated linoleic acid (CLA) was supplemented to crossbred growing-finishing pigs (n=64) at 0.75% of the total diet. Pigs were randomly assigned to the CLA or control diets based on stress genotype (negative, carrier or positive). Growth, carcass and meat quality data were analyzed. Gain:feed was significantly higher for CLA diet animals (350 g/kg feed) versus control diet animals (330 g/kg feed) independent of genotype (P<.05). No differences were observed for average daily gain for the diet or genotype classes. Percent carcass shrink at 24 h post-mortem was not affected by CLA. CLA supplemented pigs exhibited decreased 10th rib fat depth (2.34 cm vs 2.84 cm) and last rib fat depth (2.46 cm vs 2.72 cm) compared with control pigs (P<.05). Loin muscle area (LMA) was not affected by CLA supplementation, but LMA was significantly different for genotype, with stress positive genotype carcasses having the largest LMA (45.02 cm²) and negative carcasses having the smallest LMA (36.44 cm²). Carrier carcasses were intermediate for LMA (40.76 cm²). NPPC subjective scores for color were not affected by CLA, but color was significantly different with scores of 1.50, 2.40 and 3.1 for positive, carrier and negative genotypes, respectively. Subjective marbling scores were significantly increased in all genotypes with CLA supplementation. Ether extractable lipid analysis verified these increases. Subjective firmness scores were significantly higher for CLA supplemented pigs and were highly correlated (.92) to marbling scores. This study shows LMA is increased with stress carrier and stress positive genotypes, but lean color is negatively affected with the presence of the stress gene. Additionally, CLA supplementation improves feed efficiency, decreases backfat and improves pork quality attributes of marbling and firmness of the longissimus muscle.

Key Words: Conjugated linoleic acid, Swine, Meat quality

104 Compositional differences in hams and loins of CLA-fed stress genotype pigs as determined by TOBEC and primal cut dissection. J.E. Swan^{*}, B.R. Wiegand, S.T. Larsen, F.C. Parrish, Jr., and T.J. Baas, Iowa State University Ames, IA.

Sixty-four crossbred growing-finishing pigs were placed on a control (soybean oil) or CLA (0.75%) diet until harvest. Pigs were penned in pairs according to diet and stress-genotype (negative, carrier and positive). Right side hams and loins were fabricated from carcasses at 24 h post-mortem before being scanned by the TOBEC, which supplied a Phase Maximum Average (PMA) value for each primal cut. This was followed by dissection of the hams and loins into lean, fat, bone and skin components. TOBEC predicted the lean composition of the hams at an R² of 0.80. Positive pigs displayed hams with significantly higher amounts of lean than negative pigs (P<.05). Positive pigs also exhibited a higher TOBEC derived PMA value than the negative genotype pigs (P<.05). PMA values of hams were not affected by CLA, but genotype was significantly different within the CLA diet with positive and carrier values being higher than negative hams (P<.05). TOBEC predicted the lean composition of the loins at an R² of 0.66. CLA supplemented pigs exhibited increased bone and PMA values of loins compared with control fed pigs (P<.05). Independent of diet, fat composition of loins was significantly higher for positive than negative pigs (P<.05). However, these positive pig loins also portrayed higher PMA values (P<.05), which may indicate a larger loin overall. Negative pigs supplemented with CLA exhibited heavier loins compared with negative control fed (P<.05). Also,

within the control diet, positive pigs had significantly heavier loins than the negative genotype pigs ($P < .05$).

Key Words: TOBEC, CLA, Swine

105 Characterization of muscle growth in implanted feedlot heifers using a muscle cell culture system. J. L. Montgomery^{*1}, C. R. Kerth², K. J. Morrow¹, and M. F. Miller¹, ¹ *Texas Tech University, Lubbock TX*, ² *Auburn University, Auburn AL*.

Primary bovine muscle cell culture studies were conducted to determine whether heifer implants have a direct effect on in vitro cellular protein synthesis and degradation. Feedlot heifers ($n=92$) implanted with one of six implant regimes were used to characterize implant effects on amino acid uptake and protein degradation. Heifers were implanted initially at the beginning of the feedlot trial and again after 56-d. The combination of the initial and 56-d implant represented the six treatments. The six treatments were no implant/no implant, no implant/revalor[®]-h, revalor[®]-h /no implant, revalor[®]-h /revalor[®]-h, synovex-h/revalor[®]-h, and an implant containing 100 mg trenbolone acetate and 10 mg estradiol followed by revalor[®]-h, respectively. At slaughter serum was collected on each of the individual heifers. Muscle samples were collected from the longissimus lumborum at 1-h post-mortem for extraction and incubation with primary bovine muscle cells. Myoblast cultures were pretreated with serum and muscle extracts for 24 h before a 4-h synthesis or 6-h degradation measuring period. Serum samples did not differ in amino acid uptake or protein degradation. The revalor[®]-h/revalor[®]-h implant strategy increased amino acid uptake and decreased protein degradation of muscle extracts compared to the no implant/no implant regime ($P < .05$). The revalor[®]-h/revalor[®]-h implant program also increased amino acid uptake ($P < .01$) when compared to heifers implanted with revalor[®]-h and reimplanted with no implant. The revalor[®]-h/revalor[®]-h implant program also increased amino acid uptake ($P < .01$) when compared to heifers implanted with synovex-h and reimplanted with revalor[®]-h. These results indicate that anabolic agents applied through implant strategies have a direct anabolic effect on muscle cell protein synthesis and protein degradation.

Key Words: Muscle cells, Protein synthesis, Protein degradation

106 The effects of implant dosage on beef carcass characteristics and longissimus muscle. K. S. Kirchofer^{*1}, C. R. Calkins¹, C. T. Milton¹, and R. T. Brandt², ¹ *University of Nebraska, Lincoln*, ² *Hoechst Roussel Vet., Overland Park, KS*.

Beef steers were used to determine the effects of growth-promoting implants on beef carcass characteristics and longissimus muscle tenderness. Six implant treatments (40 steers per treatment) were used during a 194 d finishing period: control (no implants), 0/0, 40/8, 60/12, or 80/16 mg each of trenbolone acetate/estradiol (Revalor[®]), or a mixture of estradiol and progesterone (Synovex[®]-S) at day zero. All treatments except the control received 120/24 mg each of trenbolone acetate/estradiol (Revalor[®]-S) at re-implant time (d 84). Single degree of freedom contrasts were used to evaluate the treatments. Control steers were 23.6 kg lighter in carcass weight and 40 points of marbling higher (Small 20 versus Slight 80) than the average of all implant treatments ($P < .05$), although neither quality grade nor yield grade differed among treatments. Meat tenderness, measured with the Warner-Bratzler shear, tended to be better for the control cattle than the implanted ones (3.62 vs 3.81 kg, respectively, $P = .09$). No significant differences in carcass or muscle traits were detected with increasing implant dosages at the initiation of the feeding period. Implant combinations used in this experiment dramatically enhanced carcass weight, with minimal effects to marbling and tenderness.

Key Words: Beef, Tenderness, Implants

107 Myostatin expression in skeletal muscle of developing Meishan and Yorkshire piglets. G.R. Voelker^{*}, J.C. Conroy, and M.B. Wheeler, *University of Illinois, Urbana*.

Myostatin (GDF-8) is a member of the TGF- β superfamily of growth factors which is expressed predominantly in skeletal muscle. Myostatin is a purported negative regulator of muscle development. The double-muscling phenotype of Belgian Blue and Piedmontese cattle has been

linked to nucleotide deletions and transitions within the coding region of the myostatin gene. The objective of this study was to establish a developmental comparison of myostatin mRNA expression between developing Meishan and Yorkshire piglets. Animals for this study were selected at day 54 of gestation as well as day 14, 30 and 60 post parturition. Total RNA was isolated from gluteus muscle tissue of Meishan and Yorkshire piglets. RT-PCR was used to design a 630-bp radiolabeled probe which could be used to hybridize to the target GDF-8 sequence in Northern analysis. CollageTM image analysis software was used to quantify myostatin mRNA expression. The GDF-8 expression results illustrate a trend of increased myostatin expression in Yorkshire piglets as compared to the Meishan piglets for all four time points sampled. Significant increases of myostatin expression in the Yorkshire samples at days 14, 30 and 60 were observed as compared to the respective Meishan samples ($P < .05$). The data also indicates a trend of increased myostatin expression in the Meishan breed as progression from day 54 pre-partum to day 60 post-partum. The only significant difference ($P < .0134$) in Meishan swine was found when the day 54 pre-partum were compared to the day 60 samples. The Yorkshire samples illustrated a similar trend of increased myostatin expression as the age of development increases. Significant differences in Yorkshires were found in the following comparisons: day 54 pre-partum and day 30 ($P < .0042$), day 54 pre-partum and day 60 ($P < .0056$), day 14 and day 30 ($P < .0131$), and day 14 and day 60 ($P < .0158$). These data indicate that myostatin expression increases as both Meishan and Yorkshire piglets develop and that Yorkshire piglets express GDF-8 mRNA at higher levels than Meishan piglets of the same age.

Key Words: Pigs, Myostatin, mRNA

108 Effects of quality grade, postmortem age, blade tenderization, and endpoint cooking temperature on Warner-Bratzler shear force and sensory panel evaluation of beef gluteus medius steaks. C. D. George-Evins, J. A. Unruh, J. L. Marsden, and C. L. Kastner, *Kansas State University, Manhattan, Kansas*.

Top sirloin butts ($n=162$) were used to determine the influence of quality grade (Select, SEL; Choice, CHO; and Certified Angus BeefTM, CAB), aging period (7, 14, or 21 d), blade tenderization passes (zero, 0X; one, 1X; or two, 2X times), and endpoint cooking temperature (65.5, 71, or 76.6°C) on gluteus medius steak tenderness. Warner-Bratzler shear (WBS) evaluations were conducted on all treatment combinations and sensory panel evaluations were conducted on CHO steaks cooked to 71°C. Thawing loss was higher ($P < .05$) for steaks aged 7 d than 21 d. Cooking loss was higher ($P < .05$) for steaks aged 14 and 21 d than 7 d, and increased ($P < .05$) with each increasing endpoint temperature. Each increasing aging period resulted in lower ($P < .05$, more tender) WBS. In addition, steaks blade tenderized 2X had lower ($P < .05$) WBS than steaks blade tenderized 0X or 1X. Within each quality grade, WBS increased ($P < .05$) as endpoint cooking temperature increased. When cooked to 70 or 76.6°C, CHO and CAB steaks had lower ($P < .05$) WBS than SEL steaks. Certified Angus BeefTM steaks aged 21 d, blade tenderized 2X, and cooked to an endpoint cooking temperature of 65.5°C had no steaks with WBS values above 3.0 kg which indicates a high consumer acceptance rating for tenderness. Steaks blade tenderized 1X or 2X had higher ($P < .05$) sensory panel ratings for myofibrillar and overall tenderness than steaks blade tenderized 0X. Connective tissue amount and overall tenderness ratings were higher (more tender, $P < .05$) for steaks aged 21 d than 7 d. Postmortem aging and blade tenderization of gluteus medius steaks can improve tenderness as measured by WBS. When cooking to higher endpoint temperatures, higher quality grades should be selected to minimize toughness due to cooking.

Key Words: Beef, Tenderness, Blade tenderization

109 Effects of quality grade, postmortem age, blade tenderization, and endpoint cooking temperature on Warner-Bratzler shear force and sensory panel evaluation of beef semimembranosus steaks. C. D. George-Evins^{*}, J. A. Unruh, J. L. Marsden, and C. L. Kastner, *Kansas State University, Manhattan*.

Inside rounds ($n=162$) were used to determine the influence of quality grade (Select, SEL; Choice, CHO; and Certified Angus BeefTM, CAB), aging period (7, 14, or 21 d), blade tenderization passes (zero, 0X; one, 1X; or two, 2X times), and endpoint cooking temperature (65.5,

71, or 76.6°C) on semimembranosus steak tenderness. Warner-Bratzler shear (WBS) evaluations were conducted on all treatment combinations and sensory panel evaluations were conducted on CHO steaks cooked to 71°C. Percentage of thawing loss was higher ($P < .05$) for steaks aged 7 d than steaks aged 14 and 21 d. For CHO steaks, cooking loss was higher ($P < .05$) for steaks blade tenderized 2X steaks than steaks blade tenderized 0X and 1X. However, percentage of cooking loss was similar ($P > .05$) between SE and CAB quality grades. Cooking time was longer ($P < .05$) for steaks aged 14 and 21 d than steaks aged 7 d. Steaks aged 14 and 21 d had lower ($P < .05$) WBS than steaks aged 7 d. Cooking loss, cooking time, and WBS were higher ($P < .05$) with each increase in endpoint cooking temperature. Flavor ratings were higher for steaks aged 7 d than steaks aged 14 d and for steaks blade tenderized 0X compared to steaks blade tenderized 2X. Juiciness ratings were higher ($P < .05$) for steaks blade tenderized 0X and 1X than steaks blade tenderized 2X. Postmortem aging (14 or 21d) and lower endpoint cooking temperatures were the most effective in improving WBS of inside round steaks. Neither aging nor blade tenderization had improved sensory panel traits for CHO inside round steaks.

Key Words: Beef, Tenderness, Blade tenderization

110 Reduction of microbial pathogens in ground beef utilizing hurdle technology and a novel ozone generator. M. R. Stivarius*, F. W. Pohlman, K. S. McElyea, M. G. Johnson, J. K. Apple, A. L. Waldroup, and Z. B. Johnson, *University of Arkansas, Fayetteville.*

The objective of this study was to utilize "Hurdle Technology" and a novel ozone generator in a ground beef system to reduce the microbial load through simulated retail storage. Frozen beef trim was thawed to 4°C and inoculated with a mixture (7.0 log CFU/ml) of *E. coli* (ATCC 11775; EC) and *Salmonella typhimurium* (nalidixic acid resistant; ST). Antimicrobial treatments consisting of: 1) 1% 15 min ozonated water bath followed by mixing with 5% acetic acid (OA); 2) 1% 15 min ozonated water bath followed by mixing with .5% cetylpyridinium chloride (OC); 3) mixing with 200 ppm chlorine dioxide followed by mixing with 10% trisodium phosphate (CT); or 4) untreated control (C) were then applied to beef trimmings. Treated trim was ground twice, placed in foam trays on absorbent diapers, and overwrapped with polyvinyl chloride film. Packages were stored at 4°C under simulated retail lighting (deluxe warm white light: 1630 lx) and evaluated for aerobic plate count (APC), coliform (CO), EC, ST, instrumental color, and sensory color and odor characteristics on d 0, 1, 2, 3 and 7 of storage. Both the OA and OC treatments were effective ($P < .05$) for controlling EC, ST, CO and APC throughout storage compared to C. Likewise, the CT treatment was effective ($P < .05$) for reducing EC, CO and APC, but not effective ($P > .05$) for controlling ST through storage compared to C. The CT treatment maintained a redder ($P < .05$) color (higher a^* and 630:580 nm ratio) than all other treatments by d 7 of storage. Likewise, OA and OC treatments were lighter ($P < .05$) in color whereas CT was darker ($P < .05$) in color (L^*) than the control. Sensory panelist was unable to detect odor differences ($P > .05$) between OC, CT and C treatments. By d 2 of storage, sensory panelist found OA to be more brown in overall color and worst point color and have a higher percentage of surface discoloration than C or OC treatments. However, sensory panelists found CT to be redder ($P < .05$) in overall color than the control. Therefore it is possible to control microbial growth by using multiple interventions without detriment to ground beef quality.

Key Words: E. coli, Salmonella, Ground beef

111 Effects of ractopamine (RAC) on carcass parameters in finishing pigs. A. L. Schroeder*¹, D. H. Mowrey¹, E. E. Thomas¹, R. E. Karnak¹, L. A. Brown¹, R. W. Mandigo², F. K. McKeith³, D. M. Roth¹, and K. Prusa⁴, ¹Elanco Animal Health, ²University of Nebraska, ³University of Illinois, ⁴Iowa State University.

The objective of this multi-site study was to evaluate the effects of ractopamine HCl on carcass parameters in finishing pigs. In a randomized complete block design, separate pens of crossbred barrows and gilts were fed a corn-soybean meal diet (16% CP, 0.81% lysine) containing differing levels of ractopamine (0, 5, 10, 15 and 20 ppm) from 69 kg to 109 kg. Pigs were slaughtered after a 5 day withdrawal and evaluated for carcass parameters. Carcasses were separated into soft tissue, bone and skin. Soft tissue was chemically analyzed for ether extractable

lipids, moisture, crude protein and ash. No sex X ractopamine interaction was detected therefore data were pooled. Pigs had improved ($P \leq 0.0005$) dressing percent and increased ($P \leq 0.08$) loin eye area with ractopamine doses of 10, 15 and 20 ppm. Ractopamine produced a trend for less ($P = 0.14$) 10th rib fat thickness. Percent chemical lean (wt of soft tissue - (wt of moisture+fat+ash)/hot carcass weight)/100 was increased ($P \leq 0.04$) for 10, 15, and 20 ppm doses. Carcass fat was reduced ($P \leq 0.03$) at 10 and 20 ppm doses. Actual carcass fat free lean and NPPC calculated fat free lean was increased ($P \leq 0.04$) for 10, 15 and 20 ppm doses. The NPPC equation generally tended to underestimate the effect due to ractopamine treatment compared to actual carcass fat free lean. The following table summarizes the carcass variable results:

Variable	(RAC, ppm) ^a				
	0	5	10	15	20
Final Live Weight, kg	109.5	108.6	109.1	108.8	108.9
Hot Carcass Weight, kg	79.1	79.4	81.0	80.4	81.0
Dressing Percent, %	72.30	73.09	74.25	73.88	74.29
10th Rib Fat Depth, cm	2.91	2.89	2.67	2.85	2.66
Loin Eye Area, cm ²	33.45	35.19	37.18	35.46	36.81
Percent Chemical Lean, %	12.05	12.18	12.61	12.65	12.86
Carcass Percent Fat, %	29.0	28.9	26.7	27.2	26.5
Actual Carcass Fat Free Lean, as a % of Hot Carcass	52.33	52.81	55.60	55.23	55.37
NPPC Formula Calculated Fat Free Lean, %	52.35	52.73	54.16	53.01	54.09

^a least squares means

Key Words: Ractopamine, Swine, Carcass Composition

112 Pre-rigor injection using glycolytic inhibitors in low-quality beef muscles. N. C. Jerez*¹, C. R. Calkins¹, and J. Velazco², ¹University of Nebraska, Lincoln, ²Instituto Tecnológico y Estudios Superiores de Monterrey, Mexico.

The objective of this experiment was to determine the effect of pre-rigor injection of several glycolytic inhibitors on pH, color, tenderness, and other related traits of low-value beef cuts. The *semimembranosus*, *triceps brachii* and *supraspinatus* muscles from each of 10 steer carcasses were removed 1 h postmortem. Control samples remained in the carcass at 2°C for 24 h. Muscles were injected and tumbled with 10% of one of four different solutions: sodium citrate (NaC; 200 mM), sodium fluoride (NaF; 200 mM), sodium acetate (NaA; 200 mM), and calcium chloride (CaCl₂; 300 mM). All muscles treated with NaC and NaF showed the highest pH and glycogen content at 3 d ($P < .05$), indicating that glycolysis was inhibited. Injection of NaC in *triceps brachii* produced the most tender meat ($P < .05$) at 3 d. Tenderness also improved with NaF and CaCl₂ during aging; however, differences were of lesser magnitude ($P < .05$) after 7 d and not significant by d 14. The same trend was observed in *semimembranosus* with no significant differences. Injection of NaC, CaCl₂, or NaF in *supraspinatus* reduced shear force in 2.22, 1.73, and 1.15 kg, respectively, compared with controls at d 3; no differences were detected after 7 d. Water holding capacity and L^* value were not affected by treatments. However, treated samples showed lower a^* values than the controls of all muscles, indicating that brine injection affected color intensity of meat. Treatment did not affect oxidation-reduction potential, but all muscles became more oxidative (higher oxidation-reduction potential) after 3 d. Treated muscles had higher NAD and NADH content than controls ($P < .05$); however this change did not affect lean color. The opportunity exists to enhance the value of low-quality beef muscles using glycolytic inhibition. Sodium citrate was identified as a potential compound to enhance tenderness without altering color; further studies are required to investigate its effect on palatability traits and to provide a basis for commercial application of the process.

Key Words: Beef, Tenderness, Glycolytic inhibition

113 Effects of various levels of ractopamine (RAC) on growth performance in finishing pigs. A. L. Schroeder¹, D. H. Mowrey^{*1}, E. E. Thomas¹, G. M. Moore¹, L. E. Watkins¹, L. A. Brown¹, J. C. Parrott¹, R. E. Karnak¹, A. J. Lewis², P. S. Miller², T. R. Cline³, J. H. Eisemann⁴, R. A. Easter⁵, and W. L. Miller⁶, ¹Elanco Animal Health, ²University of Nebraska, ³Purdue University, ⁴North Carolina State University, ⁵University of Illinois.

The objective of this multi-site study was to evaluate the effects of various levels of ractopamine HCl on the growth performance of finishing pigs at various locations in the U.S. In a randomized complete block design, separate pens of crossbred barrows and gilts were fed a corn-soybean meal diet (16% CP, 0.81% lysine) containing differing levels of ractopamine (0, 5, 10, 15 and 20 ppm). A zero day withdrawal was observed in the trials. Pigs were fed ractopamine from 69 kg to 109 kg. No sex X ractopamine interaction was detected therefore data were pooled for barrows and gilts. Ractopamine improved ($P \leq 0.06$) average daily gain for all non-zero doses and decreased ($P \leq 0.04$) average daily feed intake for the 15 and 20 ppm doses. Ractopamine produced a linear improvement ($P \leq 0.0001$) in feed efficiency and gain efficiency over the range 5 to 20 ppm. The following table summarizes the growth performance variable results:

Variable	RAC, ppm				
	0	5	10	15	20
Average Daily Weight Gain (kg) ^a	0.82	0.89	0.87	0.86	0.89
Average Daily Feed Intake (kg) ^a	2.86	2.84	2.76	2.67	2.73
Feed to Gain Ratio ^a	3.51	3.22	3.18	3.13	3.08
Gain to Feed Ratio ^a	0.287	0.311	0.316	0.322	0.326

^aleast squares means

Key Words: Ractopamine, Swine, Growth Performance

114 The effects of post-harvest time and temperature on glycolytic potential of beef muscle. D. J. Hanson* and C. R. Calkins, *University of Nebraska-Lincoln.*

Measurement of glycogen and lactate at various times post mortem has been used to calculate the glycolytic potential of muscle. To determine the effects of post-harvest time and temperature on glycolytic potential in beef longissimus muscle, the right and left sides from 10 steer carcasses were randomly assigned to warm (30°C) or cold (0°C) temperature treatments. Longissimus muscle pH was measured every hour to determine rigor (defined as 2 consecutive pH readings within 0.1 unit). Full, bone-in strip loins were removed immediately after slaughter and held at 30°C until rigor (ca. 6 hr), when they were moved to 0°C. Cold-temperature loins remained within the carcass. Samples for lactate, glycogen and glycolytic potential ($\mu\text{mol/g}$) were removed 45 min post-harvest, at rigor, and 24 hr post-harvest. With the exception of lactate levels ($P < .05$) at 24 hr, temperature of storage (hot versus cold) had no significant effects on lactate (48.2 vs 46.1), glycogen (117.2 vs 125.2) or glycolytic potential (165.4 vs 171.3) at 45 min post harvest, at the point of rigor development (128.1 vs 130.2, 84.2 vs 87.5, and 212.3 vs 217.8, respectively for lactate, glycogen and glycolytic potential), or 24 hr post harvest (134.0 vs 140.6, 84.6 vs 79.5, and 221.6 vs 220.1, respectively, for lactate, glycogen and glycolytic potential). Longissimus muscle pH did not differ between hot- and cold-treated muscle at 24 hr ($P > .05$). However, time of storage did alter the calculated glycolytic potential. Glycolytic potential increased from 165.4 to 221.6 over 24 hr ($P < .01$) in warm-treated muscle and from 171.3 to 220.1 in cold-treated muscle ($P < .01$). In this study, warm treatment was associated with elevated shear force values at 1 d (5.20 vs 4.77 kg), 7 d (4.46 vs 3.72 kg), and 14 d (4.46 vs 3.40 kg) compared to cold-treated meat ($P < .05$). These data indicate that time of sampling post mortem has a significant impact on the reported value of glycolytic potential in beef longissimus muscle.

Key Words: Beef, Glycolytic potential, Tenderness

115 The effect of rendement napole genotype and time of feeding of supplemental magnesium sulfate on carcass characteristics and on pork quality. M. D. Hemann*¹, M. Ellis¹, F. K. McKeith¹, K. D. Miller¹, and K. Purser², ¹University of Illinois, Urbana-Champaign, ²Prince Agri-Products, Quincy, IL.

The objective of this study was to compare the effect of time of feeding before slaughter of a fixed level of supplemental magnesium sulfate

(MgSO₄) on carcass and pork quality traits in Rendement Napole (RN) gene carrier (RN⁻rn⁺) and homozygous recessive (rn⁺rn⁺) animals. A total of 144 pigs were allotted to one of four dietary treatments on the basis of sex (castrate and gilt), weight, and RN genotype. The treatments were: Control = no added MgSO₄; 5-d treatment = MgSO₄ fortified diet fed 5 d prior to slaughter; 3-d treatment = MgSO₄ fortified diet fed 3 d prior to slaughter; 2-d treatment = Mg fortified diet fed 2 d prior to slaughter. The MgSO₄ fortified diet was formulated to supply 3.2 grams of Mg/pig/day. Pigs were placed in individual pens with free access to water and were offered a fixed level of 2.75kg feed/day. At the end of the feeding period, animals were transported to a commercial packing facility and killed within 15 min of arrival. Fresh meat quality was measured on the longissimus. There were no treatment interactions. Carcass traits were similar across dietary treatments. Backfat thickness at the last lumbar vertebra and tenth rib were lower ($P < .05$) for (RN⁻rn⁺) compared to (rn⁺rn⁺) pigs. Carriers had lower ultimate pH ($P < .001$) and higher 48-h drip ($P < .05$) and 7-d purge ($P < .01$) loss than (rn⁺rn⁺) pigs. Drip loss was reduced ($P < .05$) for pigs fed the MgSO₄ supplemented diet for 5-d and 2-d compared to controls (8.98, 7.41, 7.89, and 7.29 for the control, 5-d, 3-d, and 2-d treatments, respectively, SEM .447). Purge loss was similar for all dietary treatments. Results from this study suggest that feeding a fixed level of supplemental magnesium prior to slaughter can reduce drip loss in both RN carrier and homozygous recessive pigs; however, further research needs to be conducted to investigate the lack of response in purge loss.

Key Words: Magnesium sulfate, RN gene, Meat quality

116 Deletion analysis of three actin-binding sites in muscle talin. H.-S. Lee*, R.M. Bellin, and R.M. Robson, *Iowa State University, Ames, IA.*

Talin is considered an important cytoskeletal protein that helps link the actin cytoskeleton and contractile apparatus to the nearby sarcolemma at the costameres and at the myotendinous and neuromuscular junctions of skeletal muscle cells. We recently have shown that purified intact muscle talin and its 190 kDa calpain-generated, C-terminal tail fragment bind to actin in a very sensitive, pH- and ionic strength-dependent manner, but that the 190 kDa talin tail binds actin less effectively than does intact talin (Schmidt et al., 1999, Arch. Biochem. Biophys. 366: 139-150). It was reported that talin contains three actin binding sites (ABS), with ABS 1 located within the 47 kDa N-terminal head fragment, and ABS 2 and 3 located within the 190 kDa tail (Hemmings et al., 1996, J. Cell Sci. 109: 2715-2726). We have further narrowed the sizes of the three ABS described in Hemmings et al. (1996), by making N- and C-terminal-deleted polypeptides, expressed as GST-fusion proteins, and assaying them by F-actin cosedimentation. All three of the GST-fusion proteins, containing the narrowed ABS of talin, have been found to cosediment with F-actin in a pH- and ionic strength-dependent manner. Additionally, a GFP-fusion construct, containing the narrowed ABS 1, was localized to actin filaments at the cell periphery of COS-1 cells following transfection. The latter results provide further support for the existence of an ABS within the head domain of talin (Hemmings et al., 1996), which some have been unable to confirm (Goldmann et al., 1999, Eur. J. Biochem. 260: 439-445). Our results in toto provide support indicating that all three ABS may be functional within cells, and that all three sites may provide the sensitivity necessary for controlling attachment of the actin cytoskeleton to the sarcolemma. (Supported in part by a USDA-NRICGP Award)

Key Words: Talin, Muscle Cell Cytoskeleton, Actin Attachment Sites

117 Influence of level of vitamin E and level and time of feeding of vitamin D₃ on growth, carcass, and pork quality characteristics in pigs. K.L. Enright¹, K.D. Miller*¹, L.L. Berger¹, F.K. McKeith¹, G. Lynch², and M. Ellis¹, ¹University of Illinois, ²BASF Corporation.

A study was carried out to investigate the impact of feeding supplementary levels of vitamins E and D₃ on growth, carcass and meat quality characteristics. Ninety-six commercial hybrid barrows and gilts were used in a randomized complete block design with a 2 x 6 factorial arrangements with 2 levels of vitamin E (30 vs 200 mg/kg of feed) fed for 42 days before slaughter, and 6 treatment combinations of vit. D₃ level (1,000 vs 90,000 vs 180,000 IU/kg of feed) and time of feeding (6 vs 9 days before slaughter). Pigs were slaughtered at approximately 110

kg live weight and subjected to standard carcass and meat quality evaluation. There was no effect of vitamin E supplementation on growth, carcass, or meat quality characteristics. Feeding 180,000 IU/kg of vit. D₃ for 9 d prior to slaughter produced a reduction ($P < .05$) in daily gain and gain:feed ratio. Serum calcium levels at slaughter were elevated ($P < .001$) for pigs supplemented with 90,000 and 180,000 compared to 1,000 IU/kg. Slaughter live weight ($P < .01$) and carcass weight ($P < .05$) were reduced for pigs fed the highest level of vit D₃ for 9 d prior to slaughter compared to the other vit. D₃ x time of feeding treatment combinations. Dressing percentage was similar across treatments. Pigs fed 180,000 IU/kg D₃ for 9 d generally had the lowest midline backfat thickness measurements; there were no consistent differences in carcass measurements between the other treatments. Pigs fed 180,000 compared to 1,000 IU/kg vit. D₃ had higher subjective muscle color and firmness scores, greater Hunter L* and a* values, and reduced drip loss, indicating an improvement in muscle color and water holding capacity. Pigs fed 90,000 IU/kg vit. D₃ for 9 d generally had similar Hunter L* and drip loss to those fed 180,000 IU/kg vit D₃. Relative to controls (1,000 IU/kg vit D₃), purge loss was reduced for pigs fed 90,000, but not 180,000, IU/kg vit D₃. These results suggest that feeding 180,000 IU/kg vit. D₃ for 6 or 9 d or 90,000 IU/kg for 9 days prior to slaughter improves pork color and water holding capacity.

Key Words: Vitamin E and D₃, Growth and carcass, Meat Quality

118 Behavior of mice selected for high and low heat loss during light and dark photoperiods. J. G. Jones* and J. L. Miner, *University of Nebraska*.

The objective was to compare the behavior of high heat producing mice (MH) with low heat producing mice (ML) during light and dark photoperiods. These lines were developed from a common stock by selection for high versus low heat loss measured by direct calorimetry. The MH mice produce approximately 50% more heat than the ML mice. The hypotheses were that both lines are more active during the dark and that MH are more active than ML mice. Fifteen MH and 15 ML 11-wk-old males were used. They were housed in six shoebox cages: three MH cages and three ML cages, with 5 mice per cage. Photoperiod was 12 h light and 12 h dark. Six behaviors were recorded by direct observation: rearing, climbing, feeding, exploring, resting, and grooming. Observations were made in four 30-min periods; two during the light and two during the dark. Behavior of each mouse was recorded during

each minute of the observation periods. Data were analyzed by analysis of variance using the GLM procedure of SAS. We detected a significant main effect of line. The ML mice spent more time resting, and less time climbing than did the MH mice ($P < .05$). We also detected a line by photoperiod interaction ($P < .05$). The ML mice rested more during the light (46%) than during the dark (28%), but the MH mice rested less during the light (1%) than during the dark (20%). Rather than resting during the light, the MH mice increased the proportion of time spent climbing from 25% during dark to 45% during light. In conclusion, MH mice spend less time resting and more time climbing than do ML mice and this difference is exaggerated during the light phase.

Key Words: Behavior, Energetics

119 Fiber type composition of the muscles of the beef chuck and round. K. S. Kirchofer*¹, C. R. Calkins¹, and B. L. Gwartney², ¹*University of Nebraska, Lincoln*, ²*National Cattlemen's Beef Association, Greenwood Village, CO*.

Thirty-eight muscles of the beef chuck and round were histochemically stained to characterize fiber type composition to facilitate optimal muscle use in value-added products. In an effort to sample beef carcass diversity, U.S.D.A. Select grade chucks and rounds (n=4 each) were chosen to represent two weight classes (250-295 kg and 363-410 kg) and two yield grades (1 and 3). Muscles were sectioned and stained with a serial staining procedure, which included a succinate dehydrogenase and an adenosine triphosphatase staining technique. Number, percentage, and cross-sectional area of β -red, α -white, and α -red muscle fibers were determined for each muscle. Weight did not significantly affect muscle fiber type ($P > .05$), probably because of limited sample numbers. Muscles containing greater than 40% β -red fiber numbers were classified as red; greater than 40% α -white were classified as white. All other muscles were classified as intermediate. Nine of twelve round muscles were white, including the semitendinosus, biceps femoris, rectus femoris, adductor, and the semimembranosus. The chuck muscles were red (10 of 26), intermediate (9 of 26), and white (7 of 26). These data indicate variable fiber type composition of most of the muscles of the beef chuck and round. Functional and biochemical traits of each muscle fiber class would be expected to create different processing characteristics, which influence optimal muscle use in value-added products.

Key Words: Beef Chuck, Beef Round, Fiber Type

NONRUMINANT NUTRITION

120 Added L-carnitine in sow gestation diets improves carcass characteristics of the offspring. R.E. Musser*¹, S.S. Dritz¹, R.D. Goodband¹, M.D. Tokach¹, D.L. Davis¹, J.L. Nelssen¹, K.Q. Owen², S. Hanni¹, J.S. Bauman³, and M. Heintz³, ¹*Kansas State University, Manhattan*, ²*Lonza, Inc., Fair Lawn, NJ*, ³*Global Ventures Inc., Pipestone, MN*.

Sows (n = 232) were provided either an additional 0 or 50 ppm of L-carnitine in the gestation diet and various aspects of sow and offspring performance were evaluated. Sows were fed a corn-soybean meal gestation diet (.7 % lysine, 1.0 % Ca, and .90 % P) with or without added L-carnitine from breeding until farrowing. Added L-carnitine had no effect ($P > .10$) in either the immediate or subsequent number of pigs born (12.7) or born alive (11.4) per litter. No differences were observed in pig weight at birth, weaning, or d 60 of age. Muscle fiber analysis of pigs (n = 28) sacrificed at birth indicated tendencies for a larger cross-sectional area of the semitendinosus muscle (128 vs 112 mm²; $P = .15$), increased primary (slow-twitch, red) fibers, and a lower ratio of secondary (fast-twitch, white) to primary fibers in pigs from sows fed added L-carnitine during gestation. Carcass characteristics were recorded for an additional 1,236 offspring. No differences were observed in the hot carcass weight (87.7 kg), but loin depth and percentage lean were increased (59.4 vs 57.0 mm; 55.1 vs 54.5 %, $P < .01$) in offspring of sows fed additional L-carnitine during gestation. Feeding added L-carnitine during gestation had no effect on the number of pigs born. Improved carcass leanness is consistent with tendencies for increased muscle size and primary muscle fiber number. These responses might be due to improved nutrient utilization in the sow allowing for improved nutrient

status of the developing fetus. More research is needed to determine the optimum level of L-carnitine to use in the gestation diet.

Key Words: L-carnitine, Gestation, Pig

121 Maternal and fetal growth and metabolic characteristics affected by increased feed intake from d 30 to 57 of gestation. R.E. Musser*, D.L. Davis, R.D. Goodband, J.L. Nelssen, and M.D. Tokach, *Kansas State University, Manhattan*.

The potential effects of maternal feed intake were evaluated by feeding either 1.81 kg/d (control, n = 6) or 7.00 kg/d (High Feed Intake (HFI), n = 4) of a gestation diet (.65% lysine, .9% Ca, and .8% P) from d 30 to 57 after breeding. Sows were subjected to surgery on d 57 of gestation and a total of 112 fetal pigs were bled and removed sequentially beginning at the ovarian end of one uterine horn. On d 57, HFI sows had gained more ($P < .01$) weight (41.2 vs 2.1 kg) than controls. Plasma from the jugular vein of the HFI sows prior to surgery (3 h post-prandial), and in the uterine vein and artery during surgery, had higher ($P < .05$) concentrations of IGF-I and urea nitrogen compared to control. However, no ($P > .10$) treatment effects were observed for sow plasma glucose or insulin concentrations. Fetal length, fetal weight, liver weight, and fetal body composition were not ($P > .10$) affected by treatments. Concentrations of glucose, IGF-I, and insulin in plasma from the umbilical vein and allantoic and amniotic fluids concentrations of glucose were not affected by treatments. Urea nitrogen was higher ($P < .05$) in fetal umbilical venous plasma, allantoic fluid, and amniotic fluid of fetuses from HFI sows compared to control sows. Litters from control sows demonstrated a negative relationship between fetal number and fetal weight (wt, g = $-2.19 \times \text{fetal no} + 122.45$; $R^2 = .43$), but fetal weights from HFI sows

were not affected by fetal number ($R^2 = .14$). Therefore, high maternal feed intake increased IGF-I concentrations in maternal plasma and urea nitrogen was elevated in fetal blood and placental fluids, but other fetal characteristics were not affected.

Key Words: Fetal, Urea nitrogen, Gestation

122 Threonine requirement of the high-producing lactating sow. D. R. Cooper^{1,2}, J. F. Patience¹, and R. T. Zijlstra¹, ¹Prairie Swine Centre Inc., ²University of Saskatchewan, Saskatoon, Canada..

Reproductive performance is steadily increasing within the pork industry; logically, amino acid requirements need to be re-defined for sows with larger litters. The objective of this study was to determine the threonine requirement of the high-producing lactating sow, and determine the effect of lysine on this requirement. A total of 418 PIC C-15 sows were assigned randomly to treatment within parity groups (1, 2 and 3+) at d 110 of gestation. Lactation diets were formulated to contain .80 % total lysine (tLys) with .30, .35, .40, .45, .50, .55, .60 or .65 % total threonine (tThr) or 1.06 % tLys with .40, .45, .50, .55, .60, .65 or .70 % tThr. Litters were standardized to a minimum of 11 piglets within 48 h after farrowing and sows had free access to feed throughout lactation. Sow ADFI exceeded expectation, averaging 6.9, 7.4 and 7.2 kg/d for parity 1, 2 and 3+, respectively. Daily tLys intake was 57.6 g/d (46.8 g dLys/d) and 74.2 g/d (58.8 g dLys/d) for the low and high lysine group, respectively. Lysine intake did not affect sow or litter performance ($P > .10$). Sows gained an average of 4.8 kg in lactation; BW gain was maximized at .54 % tThr for all parity groups (quadratic; $P < .05$). Litter weaning weight (67.2, 68.0 and 66.3 kg for parity 1, 2, and 3+, respectively) and litter weight gain (2.49, 2.53 and 2.44 kg/d for parity 1, 2 and 3+, respectively) were maximized at .53 % tThr for all parity groups (quadratic; $P < .05$). Plasma urea nitrogen on d 10 and 18 was minimized at .54 % tThr ($P < .05$). Lysine levels in excess of 57.6 g tLys/d did not benefit sow or litter performance. The requirement for threonine to minimize sow tissue mobilization was 37.3, 40.0 and 38.9 g tThr/d (28.7, 30.8, 30.0 g dThr/d) for parity 1, 2 and 3+ sows, respectively. The threonine required to maximize litter performance was 36.6, 39.2 and 38.2 g tThr/d (28.2, 30.2, 29.5 g dThr/d) for parity 1, 2 and 3+ sows, respectively. Alternatively, the requirement can be expressed as 15.3 g tThr/kg (11.8 g dThr/kg) litter gain.

Key Words: Sows, Lactation, Threonine

123 Bioavailability of phosphorus in meat and bone meal varying in origin, particle size, and processing pressure for chicks. S.L. Traylor*, G.L. Cromwell, and M.D. Lindemann, University of Kentucky, Lexington.

The bioavailability of P in meat and bone (MBM) was determined in chicks using MBM that varied in origin, particle size, and processing pressure. Newly hatched, male chicks were placed in batteries and fed a standard diet (23% CP). On d 3, 420 chicks (66 g mean BW) were allotted to 12 diets (5 pens of 7 chicks/pen). A corn-soybean meal-starch-basal diet (21% CP, 1.0% Ca, .52% total P, and .25% non-phytate P) was used. Graded levels (.05, .10, and .15% added P) of monosodium phosphate (MSP, Diets 2-4) were added to the basal diet. MBM (.15% added P) varying in origin (low-ash [23.1%] of pork origin, 50:50 blend, or high-ash [42.7%] of beef origin), particle size (6- or 12-mesh), and processing pressure (0, 30, or 60 psi beyond normal processing) replaced starch in the basal diet for Diets 5-12, respectively. Ca was maintained at 1.0% in all diets. Chick 14-d gains and feed:gains were: 279, 366, 455, 502, 500, 501, 487, 502, 476, 487, 483, 510 g; 1.45, 1.37, 1.31, 1.28, 1.20, 1.21, 1.27, 1.24, 1.34, 1.24, 1.26, 1.23. Tibia strength (6.98, 13.41, 23.41, 34.12, 27.65, 27.84, 27.28, 30.93, 26.19, 27.97, 26.94, 29.64 kg) and ash (28.4, 32.7, 37.4, 41.3, 38.5, 38.7, 38.9, 39.5, 38.2, 38.5, 38.8%) along with growth rate, increased linearly ($P < .001$) with increasing levels of P from MSP. Addition of .15% added P from MSP compared to MBM improved bone traits ($P < .001$), but not growth ($P = .21$). The coarser MBM (6- vs 12-mesh) resulted in increased gain and bone traits ($P < .03$), and a higher processing pressure for MBM increased gain ($P < .02$) but not bone traits ($P = .21$). Bone traits were regressed on added P intake for each P source. Based on slope-ratio (MSP=100%) the bioavailability of P was 82, 83, 79, 90, 73, 82, 79, and 85% for the 8 MBM treatments, respectively. These results indicate that the availability of P in MBM is relatively high for chicks (82%). Extremes in

MBM processing pressure and source had little effect on P availability, but particle size of MBM affected both growth and bone traits.

Key Words: Chicks, Phosphorus, Meat and Bone Meal

124 Limiting order of amino acids and the effects of phytase on protein quality in corn gluten meal fed to young chicks. C. M. Peter*, Y. Han, S. D. Boling, C. M. Parsons, and D. H. Baker, University of Illinois at Urbana-Champaign.

An amino acid deletion assay and a slope-ratio growth assay were used to establish the limiting order of amino acids (AA), and to determine the effects of microbial phytase (MP) on protein utilization in corn gluten meal (CGM) fed to chicks during the period of 8 to 21-d posthatching. In assay 1, an AA-deficient cornstarch-dextrose basal diet containing 12% CP furnished by CGM was fortified with AA to fulfill the digestible AA ideal profile (Phe + Tyr, Leu, and Pro from CGM exceeded requirements) for 0- to 21-d-old chicks. Amino acids were then individually deleted, and all diets were fortified to 23% CP, with Glu varying as necessary. A Met-fortified 23% CP corn-soybean meal (C-SBM) diet was added to serve as a positive control. Each of the dietary treatments was fed to triplicate groups of five chicks. No differences ($P > .10$) were observed between the fully-fortified CGM basal diet and the C-SBM positive-control diet. The limiting order of amino acids established in CGM was 1) Lys, 2) Trp, 3) Arg, 4) Thr, 5) Val, 6) Ile, 7) His, 8) Met + Cys, and 9) Met. Glycine was not found to be deficient. In assay 2, graded levels of protein (8, 16, and 24% CP) furnished by CGM were fed in the presence and absence of 1200 U/kg MP to four groups of four chicks per treatment. Weight gain and gain:feed were then regressed on CP intake, multiple linear regression analysis was performed, and slope-ratio methodology was applied for graded levels of CGM protein fed with or without 1200 U/kg MP. Weight gain and gain:feed increased linearly ($P < .05$) as a function of protein intake, but MP supplementation had no effect ($P > .10$) on weight gain or gain:feed slopes. Additionally, MP supplementation had no effect ($P > .10$) on protein efficiency ratios at any level of CP. These results indicated that 1200 U/kg MP did not increase either CP or AA utilization in CGM for young chicks.

Key Words: Corn Gluten Meal, Phytase, Protein Quality

125 Effects of excess protein or methionine on the requirement for vitamin B-6 in chicks. C.S. Scherer* and D.H. Baker, University of Illinois, Urbana, IL USA.

Several 12-d growth assays were conducted to study the effects of excess protein and methionine (Met) on the B-6 requirement of chicks. A cornstarch, sucrose, soy protein isolate (SPI) basal diet was used in all assays. Comparisons of this diet with a B-6 free amino acid diet confirmed that the SPI basal diet contained no bioavailable B-6 activity. In assay 1, 224 male chicks were weighed and randomly assigned to 14 diets (4 reps/diet with 4 chicks/rep). Diets consisted of vitamin B-6 (from pyridoxine) levels of .2, .4, .6, .8, 1.0, and 1.2 mg/kg diet with 20% protein, and .2, .4, .6, .8, 1.0, 1.2, 1.4, and 1.6 mg/kg with 40% protein. Quadratic ($p < .01$) growth responses to B-6 occurred with both diets. At 20% protein, maximal growth was obtained at .63 mg/kg B-6, but at 40% protein, the requirement was increased to .91 mg/kg. In assay 2, 224 male chicks were weighed and randomly assigned to 14 diets (4 reps/diet with 4 chicks/rep). Vitamin B-6 was added to each diet in a design similar to that of assay 1, except that the B-6 levels ranged from .2 to 1.4 mg/kg with .2 mg/kg increments. Treatments 1 to 7 had no supplemental Met whereas treatments 8 to 14 had 1.0% added Met. The basal diet contained .2% DL-Met so that no chicks were Met deficient. Without excess Met, optimal growth was obtained at .73 mg/kg B-6, but 1% excess Met increased the requirement for optimal growth to 1.05 mg/kg B-6. It can be concluded that excess protein increases the vitamin B-6 requirement of chicks, and that the excess methionine component of protein is a principal contributor. It appears that the transsulfuration pathway together with the need for de novo methyl groups (for homocysteine remethylation) via serine hydroxymethyltransferase are major contributors to the B-6 requirement of chicks.

Key Words: Chicks, Vitamin B-6 Requirement, Excess Protein

126 Effects of diet processing on growth performance of early-weaned pigs. J. T. Sawyer, J. C. Woodworth*, J. L. Nelssen, M. D. Tokach, R. D. Goodband, and S. S. Dritz, *Kansas State University*.

Early-weaned pigs (n=384; initially 5.5 kg and 14 d of age) were used to determine the effects of diet processing technique on growth performance. Pigs were blocked by initial weight and randomly allotted to one of four dietary treatments. Diets were manufactured and fed as unprocessed meal (M), universal pellet cooker-conditioned pellets (UPC), standard-conditioned pellets (P), or expanded, but not pelleted meal (EM). There were eight pigs per pen and initially eight (M and EM) or sixteen (UPC and P) pens per treatment. Diets were fed in three phases d 0 to 7, d 7 to 14, and d 14 to 28 with decreasing nutrient concentrations in each phase. Diets fed from d 0 to 7 (1.7% lysine) contained 25% whey, 6.7% spray-dried animal plasma (SDAP), and 1.75% spray-dried blood meal (SDBM). Diets fed from 7 to 14 (1.55% lysine) contained 20% whey, 2.5% SDAP, and 2.5% SDBM. On d 14, pigs fed UPC or P diets were used to further test the influence of processing technique on diet complexity. Pens of pigs fed UPC or P diets were randomly allotted to complex (CX; 10% whey, 2.5% SDBM, and 28% SBM) or least cost (LC; 0% whey and SDBM, and 38% SBM) formulations. Pigs fed M or EM diets were maintained on CX diets processed by the same method. From d 0 to 14, ADG and G/F were 250, 277, 281, and 259; and .86, .99, 1.03, and .94 for pigs fed M, UPC, P, and EM, respectively. Pigs fed P or UPC diets had improved ($P < .05$) ADG and G/F, with pigs fed M diets having the poorest ADG and G/F. From d 14 to 28, ADG and G/F were 503, 435, 485, 481, 544, and 472; and .63, .61, .66, .66, .75, and .68 for MCX, UPCCX, UPCLC, PCX, PLC, and EMCX, respectively. Pigs fed the PCX diet had numerically the highest ADG and best G/F compared to the other treatments; however, ADG and G/F were not different from MCX. Complex pelleted or UPC diets had numerically improved growth performance compared to LC diets. In summary, processing technique influences growth performance more in early nursery phases than in later, with pigs fed UPC or P diets having the best growth performance.

Key Words: Pigs, Growth, Diet processing

127 Floor-feeding enhances early appetite of weaned pigs. I. Mavromichalis* and D. H. Baker, *University of Illinois at Urbana-Champaign*.

Early-weaned pigs frequently experience starvation and (or) depressed appetite for the first few days after weaning. Poor growth during the first week postweaning results in increased days to market, and increased mortality and morbidity. To stimulate early feed consumption, pigs were offered a generous amount of a complex starter diet on a rubber floorboard (50 cm x 40 cm) with rims, placed in front of the five-hole self-feeder in each pen. In Exp. 1, 80 weaned pigs (5.6 kg) were randomly assigned (8 replicates/treatment and 5 pigs/pen) to receive a meal diet or nothing on the floorboard (at 0800, 1200, and 1600) for 7 d postweaning. All pigs had access to the same meal diet in self-feeders. Pigs with access to feed from floorboards grew 150% faster (175 vs 71 g/d; $P < .01$) than pigs with access only to feed from self-feeders. In Exp. 2, 45 weaned pigs (5.2 kg) were randomly assigned (3 replicates/treatment and 5 pigs/pen) to receive meal, pellets, or nothing on the floorboard (at 0800, 1200, and 1600) for 3 d postweaning. All pigs had access to the same diet in pellet form in self-feeders from d 0 to 7 postweaning. During the first 3 d, total feed intake (self-feeders and floorboards) was 364, 82, and 80 g/d and weight gain was 330, 91, and 31 g/d for pigs offered meal, pellets, and nothing on the floorboard, respectively. Surprisingly, pigs that were offered pellets on the floorboard did as poorly ($P < .05$) as pigs that were offered nothing on the floorboard, whereas pigs offered meal on the floorboard exhibited marked improvements in performance ($P < .01$). Overall (d 0 to 7 postweaning) feed intake was 194, 151, and 154 g/d whereas growth rate was 232, 169, and 133 g/d for pigs offered meal, pellets, and nothing on the floorboard, respectively. In conclusion, pigs with access to a complex starter diet in meal form and fed for only 3 d on floorboards had greater overall performance ($P < .01$) than pigs with access to pellets or nothing on the floorboard. Frequent floor-feeding with a diet in meal form stimulates nursery pigs to consume large quantities of solid feed after weaning.

Key Words: Nursery Pigs, Floor Feeding, Feed Management

128 Effects of feeder design (conventional dry, Crystal Spring dry and Crystal Spring wet/dry) on growth performance, water usage, and stomach morphology in finishing pigs. N. Amornthwaphat*, J. D. Hancock, K. C. Behnke, R. H. Hines, G. A. Kennedy, D. W. Dean, C. W. Starkey, D. J. Lee, C. L. Jones, and L. J. McKinney, *Kansas State University, Manhattan*.

A total of 180 crossbred pigs (average initial BW of 54 kg) were used to determine the effects of feeder design on growth performance, water usage, nutrient digestibility, carcass characteristics, and stomach morphology. There were 12 pigs (six barrows and six gilts) per pen and five pens per treatment. Treatments were a corn-soybean meal-based diet fed through: 1) a conventional two-hole dry feeder (Smidley®, Style B 1/2, No. 2); 2) a single-hole shelf feeder (Crystal Spring®, F-5000); and 3) the single-hole shelf feeder used as a wet-dry feeder (i.e., with a nipple water mounted in the trough). The diets were formulated to .95% and .80% lysine for 54 to 82 and 82 to 115 kg BW, respectively, and fed in a meal form. Pigs fed from the two-hole conventional and single-hole shelf feeders had similar growth performance and water usage. However, pigs fed from the wet-dry shelf feeders had 6.8% greater ADG ($P < .09$) and used 23% less water ($P < .05$) than those fed from the same feeder design used as a dry feeder. There were no differences for digestibilities of DM and N, carcass characteristics, and stomach ulcer (scored on a scale of 0 to 3) among pigs fed from the different feeder types ($P > .61$). We concluded that the wet-dry feeder design increased ADG and decreased water usage in finishing pigs.

	Conventional dry	Crystal Spring dry	Crystal Spring wet-dry	SE
ADG, g	941	929	992	66
Gain/feed, g/kg	361	346	353	5
Water, L/pig/d	5.1	5.4	4.4	.3
DM digestibility, %	89.9	89.6	90.2	.5
Fat thickness, mm	26.2	24.4	25.4	.8
Ulcer score	.50	.43	.48	.10
Keratinization score	.08	.04	.08	.05

Key Words: Wet/dry Feeder, Stomach Ulcers, Pig

129 Effects of feeder design and particle size of corn on growth performance, water usage, and stomach morphology in finishing pigs. N. Amornthwaphat*, J. D. Hancock, K. C. Behnke, R. H. Hines, G. A. Kennedy, D. W. Dean, D. J. Lee, J. S. Park, C. L. Jones, and L. J. McKinney, *Kansas State University, Manhattan*.

A total of 192 crossbred pigs (average initial BW of 52 kg) were used to determine the effects of feeder design and particle size of corn on growth performance, water usage, carcass characteristics, and stomach morphology. There were 12 pigs per pen and four pens (two pens barrows and two pens gilts) per treatment. Treatments were diets with coarse (1,000 to 1,100 microns) and fine (500 to 600 microns) corn fed through a conventional two-hole dry feeder (Smidley®, Style B 1/2, No. 2) and a single-hole wet-dry shelf feeder (Crystal Spring®, F-5000). The diets were formulated to .95% and .80% lysine for 52 to 92 and 92 to 111 kg BW, respectively, and fed in a meal form. Pigs fed from wet-dry feeders had 5.4% greater gain/feed ($P < .007$) than pigs fed from conventional feeders. Also, pigs fed diets with finely ground corn had 3.1% greater gain/feed ($P < .07$) regardless of feeder design (i.e., no feeder design x particle size interactions, $P > .96$). Dramatic decreases (58%) in water usage were observed in pig fed from wet-dry feeders ($P < .001$). Particle size of corn did not affect water usage in pigs fed from the wet-dry feeders, but in the conventional dry feeder, there was decreased water usage when corn particle size was decreased (feeder design x particle size interaction, $P < .09$). There were no differences for carcass characteristics among pigs fed from the different feeder designs or the different corn particle sizes ($P > .98$). However, keratinization of the stomach (scoring scale of 0 = normal to 3 = severe) increased with reduced particle size ($P < .001$) regardless of feeder design. In conclusion, pigs fed from wet-dry feeders had greater gain/feed and used less water than pigs fed from conventional dry feeders. Furthermore, gain/feed was increased with finely ground corn regardless of feeder design.

	Conventional		Crystal Spring		
	dry		wet-dry		
	Coarse	Fine	Coarse	Fine	SE
ADG, g	970	978	999	1,007	22
Gain/feed, g/kg	349	360	368	379	5
Water, L/pig/d	8.7	7.6	5.2	5.1	.2
Fat thickness, mm	23.4	24.0	23.5	23.8	.8
Ulcer score	.00	.09	.01	.02	.03
Keratinization score	.10	.76	.20	.36	.09

Key Words: Feeder Design, Particle Size, Pig

130 Weighing accuracy in feedmills. T. van Kempen^{*1}, B. Park², M. Hannon³, and P. Matzat³, ¹North Carolina State University, ²Park Consulting, ³Roche Animal Health and Nutrition.

The ability to mix a quality feed is often equated to the quality of the mixer; the ability to weigh ingredients correctly has received little attention. To assess how accurately feedmills weigh out their ingredients, 14 feedmills specializing in swine diets were surveyed which yielded 8432 data points (for 229 ingredients and 11 to 44 batch records per ingredient). Amounts actually weighed (according to scale readings) were compared to calls and relative differences were analyzed statistically. Feedmills overdosed ingredients by 1.516.3%: between mills overdosing ranged from -0.7 to 13.0%. Weighing errors within the range of -10 to 10% were distributed normally. Over the entire range, though, a tailing to the right was observed suggesting that large weighing errors tended to be overdosing errors. Within-ingredient weighing variation ranged from 0.58 to 11.1% between mills and averaged 5.2%. Weighing errors and within ingredient weighing variation were correlated with large weighing variation leading to overdosing. Weighing errors were not associated with hand-dosing of ingredients nor were micro-ingredients per definition weighed with more error. A portion of the weighing problems observed was attributed to discrepancies between the call size and the scale resolution. For example, weighing 11.3kg on a scale with a 2kg resolution leads to a minimum error of 6%. Such problems occurred for 8.7% of the calls and resulted in a minimum error ranging from 0.01 to 20%, averaging 1.95%. Poor choice of scales was the major source of errors in weighing, and the relationship: weighing variation = $10^{1.56-0.50 \cdot \log(\text{call}/\text{scale resolution})}$ explained 40% of the variation observed ($P < 0.05$). Based on this equation, a ratio of 20 (e.g., 100kg call weighed on a scale with a 5kg resolution) results in a weighing variation of 8%. Weighing this same call on a scale with a 0.1kg resolution reduces weighing variation to 1.1%. Weighing ingredients in the right scale would thus benefit feed quality but also reduce diet cost as it would reduce the overdosing of ingredients.

Key Words: Precision Nutrition, Feed Milling, Weighing Accuracy

131 Effect of particle size and enzyme supplementation on nutrient excretion of growing pigs. M.A. Oryschak^{*1,2}, P.H. Simmins³, and R.T. Zijlstra¹, ¹Prairie Swine Centre Inc., ²University of Saskatchewan, Saskatoon, Canada, ³Finnfeeds International Ltd., Marlborough, UK.

The output of nitrogen (N) and phosphorus (P) is a growing public concern in areas with intensive livestock operations. The effect of particle size (PS) and enzyme supplementation on N and P excretion was investigated in a 4 x 3 factorial arrangement, with three particle sizes (400, FPS; 700, MPS; and 850 μ m, CPS) and four enzyme treatments (control, CON; β -glucanase/xylanase (444 and 1385 U/kg diet), CHO; phytase (374 U/kg diet), PHY; and CHO+PHY). Diets (70% barley, 25% peas) were formulated to contain 3250 kcal DE/kg, 1.6 g digestible Lys/Mcal and 0.12% available P, and were fed in wet mash form at 3 x maintenance DE. Pigs (25.3 \pm 1.4 kg) were used in three 21-d periods to obtain five observations for each dietary treatment. Treatments were assigned randomly, each treatment being fed at least once per period. Pigs were housed in individual metabolism pens. Feces and urine were collected quantitatively to calculate total N and P excretion and to partition excretion into fecal and urinary components. For DM and CP digestibility an interaction between PS and enzyme treatment was observed ($P < 0.05$). Reductions in fecal N excretion of 16.5% and 23.6% were observed for FPS over MPS and CPS, while CPS lowered urinary N excretion by 12.8% and 11.2% compared to FPS and MPS respectively

($P < 0.05$). Total N excretion was reduced by 6.8% with FPS compared to MPS ($P < 0.05$). Increases in DE of 2% and 2.7% were seen with FPS compared to CPS and MPS, respectively ($P < 0.05$). Excretion patterns of both N and P were unaffected by CHO ($P > 0.10$). Total N excretion was reduced by 5.5% with PHY compared to CON, while fecal and total P excretion were lowered by 35% and 22.4% with PHY and CHO+PHY respectively, compared to CON ($P < 0.05$). Results suggested that PS had a greater effect on N excretion, while PHY supplementation affected P excretion. Based on N excretion patterns and retention, DE was probably not limiting protein deposition.

Key Words: Particle size, Enzyme supplementation, Nutrient excretion

132 Respiratory disease challenge effects on N balance, IGF-I, organ weights, and carcass characteristics in growing pigs. J.A. Loughmiller^{*}, S.S. Dritz, J.L. Nelsens, M.D. Tokach, R.D. Goodband, and B.W. Fenwick, Kansas State University.

Castrated pigs (30 1 kg; PIC) were allotted in a randomized incomplete block design to determine the effects of an acute respiratory challenge on N balance, IGF-I, organ weight, and carcass traits. Pigs (n=30) were challenged on d 0 with Actinobacillus pleuropneumonia (APP), unchallenged and fed ad libitum (AL; n=7), or unchallenged and pair-fed the feed intake of an APP pig (PF; n=10). Collection periods were d -4 to -1, 0 to 3, 4 to 7, 8 to 11, and 14 to 17. Plasma was collected on d -3, 1, 5, 9, and 15. Treatment and linear time effects ($P < 0.01$) were observed for DM digestibility with treatment and quadratic time effects ($P < 0.05$) for N digestibility. Increased DM and N digestibility for APP pigs versus AL pigs was observed from d 0 to 3 and d 14 to 17 ($P < 0.05$) and versus PF pigs from d 0 to 3 and d 4 to 7 ($P < 0.05$). A treatment by time interaction ($P < 0.05$) was observed for N retained and treatment and quadratic time effects ($P < 0.01$) were found for urinary N. Greater N retention was observed for AL pigs versus APP pigs ($P < 0.01$) from d 0 to 3 (33.9 v 21.6 g/d) and 4 to 7 (38.1 v 23.4 g/d) and PF pigs ($P < 0.03$) from d 0 to 3 (33.9 v 24.7 g/d), 4 to 7 (38.1 v 20.4 g/d), and 8 to 11 (36.8 v 27.1 g/d). Urinary N was lower ($P < 0.04$) for PF versus AL from d 4 to 7, 8 to 11, and 14 to 17 and versus APP from d 0 to 3 and 8 to 11. Urinary N did not differ for AL versus APP ($P < .48$). Plasma IGF-I (treatment and quadratic time effects; $P < 0.03$) was lowest on d 1 for APP (155 ng/mL) versus AL (274 ng/mL; $P < 0.01$) and PF (275 ng/mL; $P < 0.01$). The IGF-I levels for APP tended to remain lower ($P < 0.10$) than AL through d 9, with PF having intermediate levels. Carcass traits and organ weights were not affected, except stomach weight was greater for PF versus AL ($P < 0.01$) and APP ($P < 0.02$). Results indicate that an acute respiratory challenge decreases N retention, which partially recovers by d 17 after challenge. The decreased N retention is due to reduced feed intake and increased proteolysis to support the immune response.

Key Words: N balance, disease, IGF-I

133 The effects of dietary feather meal concentration and space allocation on growth performance and carcass characteristics of barrows. K.-W. Ssu^{*1}, M. C. Brumm², P. S. Miller¹, and R. L. Fischer¹, ¹University of Nebraska-Lincoln, ²Haskell Agriculture Lab, University of Nebraska.

Two hundred ten barrows and 45 gilts (initial wt 36 kg) of high lean gain potential were divided into five weight blocks to determine the effects of feather meal (FM) and pen space allocation on growth performance and carcass characteristics of barrows. The experiment was a 2 (0 and 20 % FM, F0 and F20) x 2 (.75 [UC] and .56 [C] m²/pig [9 and 12 pigs/pen, respectively], space allocation) factorial treatment design with one control gilt (CG) group. Gilts were fed diets without FM from the start of the experiment to slaughter with a space allocation of .75 m²/pig. Barrows assigned to F20 treatment were switched to FM diets when average pen weight was 72 kg. All treatment diets were formulated to be isocaloric within each phase. Diets for F0 contained .71, .59 and .49 % true ileal digestible lysine, while CG and F20 diets contained .78, .68 and .57 % from 36 to 60, 60 to 86, and 86 to 110 kg, respectively. Pigs were slaughtered and TOBEC data were collected on the week average pen weight was greater than 107 kg. There was no interaction ($P > .1$) between FM and space. Dietary FM addition decreased ADFI (F0 vs F20, 2.49 vs. 2.41 kg, $P < .05$) of barrows and had no effect on all other criteria. Crowding decreased ADG (C vs UC, .72 vs .75 kg, $P < .05$) and ADFI (C vs UC, 2.39 vs 2.51 kg, $P < .01$) of barrows and

increased days to market (C vs UC, 99.8 vs 95.6 days, $P < .05$). Neither space nor FM reduced backfat depth or improved carcass leanness of barrows ($P > .1$). The combination of low space allocation and FM reduced barrow feed intake (F20C vs CG, 2.35 vs 2.32 kg, $P > .1$) to a level similar to gilts but resulted in decreased lean gain (F20C vs CG, 270 vs 294 g/day, $P < .05$). Backfat depth and carcass lean percentage of barrows was not improved (F20C vs CG, 2.03 vs 1.78 cm, $P < .05$; 49.10 vs 51.59%, $P < .01$, respectively) compared to gilts. These data suggest crowding was more effective in decreasing barrows' growth rate than dietary FM additions.

Key Words: Barrows, Feather Meal, Space Allocation

134 Effect of litter size on amino acid mobilization among different tissues in lactating sows. S. W. Kim* and R. A. Easter, *University of Illinois*.

Twenty-eight primiparous sows were used to determine the effect of litter size on nutrient mobilization in lactating sows. Litter size was set to 6, 7, 8, 9, 10, 11, or 12 pigs within 2-d postpartum by cross-fostering. Four sows were allotted to each litter size group. Sows were allowed to consume a maximum of 13.6 Mcal ME and 46.3 g lysine per day during lactation. Sows were slaughtered on d 20.6 ± 1.1 of lactation. Liver, gastrointestinal tract (GIT, composed of the empty stomach, empty small and large intestines, cecum and rectum), reproductive tract, and other organs (excluding liver, GIT, reproductive tract, and mammary gland) were separated from the carcass. Gastrointestinal tracts were manually stripped of contents and flushed with water to remove digesta. Hot carcasses were split longitudinally at the midline after removing mammary glands. Individual organs and carcasses were weighed and ground for chemical analysis. Dry matter, protein, and amino acid contents were measured. During the 21-d lactation, there were 32.32, 1.03, 0.51, 0.43, and 0.64 g lysine mobilized from carcass, GIT, liver, uterus, and other organs, respectively, for each one pig increase in litter, while there was 2.56 g lysine accumulation in mammary tissue. There were 14.96, 0.36, 0.29, 0.15, and 0.33g methionine mobilization from carcass, GIT, liver, uterus, and other organs, respectively, for each one pig increase in litter, while there was 0.79 g methionine accumulation in mammary tissue. There were 12.68, 0.76, 0.61, 0.27, and 0.46g threonine mobilization from carcass, GIT, liver, uterus, and other organs, respectively, for each one pig increase in litter, while there was 1.50 g threonine accumulation in mammary tissue. Ninety three percent of lysine mobilized from all tissue was of carcass origin. The uterus contributed more lysine than any other organs.

Key Words: Sow, Amino Acid Mobilization, Lactation

135 Supplemental copper proteinate for sows. J. T. Yen*, J. J. Ford, and J. Klindt, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE*.

Our previous study showed that supplemental copper proteinate (CuP) increased the percentage of first- and second-parity sows bred ≤ 7 d postweaning from 70 to 87%. In the present study, three trials were conducted to determine the effect of supplemental CuP on the litter size of sows bred ≤ 7 d postweaning. Sows (77, 59 and 56 in Trials 1, 2 and 3, respectively) assigned to basal (B) or CuP treatments were moved into farrowing crates at d 108 of gestation. Each sow was fed once daily 2.72 kg of a lactation diet before farrowing and to appetite during lactation. The diet fed to each CuP sow was top-dressed daily with 128 mg of CuP during both pre-farrowing and lactating periods. Pigs were weaned at 18 d of age. After weaning, sows in Trials 1 and 2 were housed in solid-floor breeding pens with a shallow open gutter, whereas sows in Trial 3 were housed in pens used in our previous study with partially slotted floor. Each B sow was fed once daily 1.82 kg of a basal gestation diet, whereas the CuP sow was fed 1.82 kg of the basal gestation diet supplemented with 23 ppm CuP. Weaned sows were checked for estrus once daily with boars for 14 d and artificially inseminated (AI) on 2 successive days at the first postweaning estrus. Within 3 d after mating, sows were moved to gestation pens and fed once daily 1.82 kg/sow of B or CuP gestation diet until they were slaughtered 108 d after the first AI. Combined data of Trials 1 and 2 showed that, for B and CuP groups, percent sows bred ≤ 7 d postweaning were 60 and 55%, percentage of sows pregnant were 42 and 39%, corpora lutea (CL)/sow were 14.0 and 14.3 and live fetuses/sow were 6.9 and 7.4, respectively.

No statistical treatment difference ($P > .05$) was found. A numeric advantage for CuP over B existed in Trial 3 when sows were housed in the same breeding facility as our previous study. For B and CuP groups of Trial 3, sows bred ≤ 7 d postweaning were 73 and 80%, sows pregnant were 46 and 60%, CL/sow were 15.3 and 16.2 and live fetuses/sow were 8.4 and 9.9 ($P = .13$), respectively. It is concluded that, with favorable housing, supplemental CuP improves reproductive performance of sows.

Key Words: Sows, Copper Proteinate, Reproductive Performance

136 Effect of chromium picolinate on parity one sow reproductive and farrowing performance. S.S. Dritz*, M.D. Tokach, R.D. Goodband, and J.L. Nelssen, *Kansas State University, Manhattan*.

Supplemental chromium picolinate (200 ppb) or similar control diets without supplementation were fed to gilts (PIC C-22) from 23 kg through farrowing their first litter. During gilt development, gilts were housed in fully slatted, environmentally regulated finisher rooms. Gilts were then transferred from the gilt finisher site to one of 2 - 1,500 sow farms in groups of approximately 25 per week. An interaction ($P < .04$) between farm and treatment was noted for transfer age due to a management decision to delay transfer of control gilts to one farm at a slightly older age ($178.7 \pm .5$ vs $180.9 \pm .7$ d of age for chromium supplemented and control, respectively). After transfer, gilts were group housed in an acclimation room and heat checked daily. All gilts were bred by artificial insemination and were placed in gestation stalls immediately after breeding. The gilts then remained in the same stall until they were either detected open or moved to the farrowing house on d 112 of gestation. Gilts were full-fed during development and acclimation and fed according to body condition (1.8 to 2.7 kg/d) during gestation. All diets during development and gestation met or exceeded NRC (1998) recommendations. The mean age at first service was 9.3 days older ($P < .01$; 235.1 ± 1.8 vs 226.4 ± 2.7 d) for chromium supplemented compared with control gilts. A total of 343 chromium supplemented and 148 control gilts were used for the study at first service. The percentage of culls before first service and first service farrowing rate were not different between treatments (4.1 vs 3.9% and 74.5 vs 79.7% for chromium and control treatments, respectively). Total ($10.8 \pm .2$ vs $10.7 \pm .3$) and live ($9.6 \pm .2$ vs $9.5 \pm .3$) pigs born in parity 1 were not different between chromium supplemented and control gilts. In this experiment, feeding chromium picolinate during development and gestation did not influence reproductive and farrowing performance of parity 1 sows.

Key Words: Sows, Chromium Picolinate, Litter Size

137 Use of chromium tripicolinate to improve pigs born alive confirmed in multiparous sows. M. D. Lindemann*¹, R. E. Hall², and K. W. Purser³, ¹*University of Kentucky, Lexington*, ²*Land O'Lakes, Inc., Fishers, IN*, ³*Prince Agri Products, Inc., Quincy, IL*.

Multiparous Cotswold sows ($n = 294$) from a commercial production facility were used to evaluate the effect of supplemental Cr from chromium tripicolinate (CrP, CHROMAX[®] 0.04%, Prince Agri Products, Inc., Quincy, IL) on litter size. Sows were assigned to dietary treatment (0 or 200 ppb Cr from CrP in corn-soybean meal based diets) based on parity. Dietary treatments were initiated following weaning and were continued for up to three reproductive cycles. When data were summarized across all cycles, CrP-supplemented sows farrowed more ($P < .05$) total (12.39 vs 11.45) and live pigs/litter (11.45 vs 10.77) than unsupplemented sows. There was no treatment effect on weaned pigs/litter (mean of 8.83). When data for the first cycle were compared to that for cycles 2 and 3, it revealed a larger increase in litter size at birth with CrP usage during cycles 2 and 3 than during cycle 1. CrP-supplemented sows farrowed .35 more ($P > .20$) live pigs than control sows for cycle 1 and 1.33 more ($P < .05$) live pigs/litter for cycles 2 and 3. Historical averages for the herd were 10.77 and 10.15 total and live born pigs, respectively. The response to CrP supplementation in total and live pigs/litter, then, was observed even though control sow values exceeded historical averages. However, pigs weaned/litter was very similar to the historical average of 8.89 (8.81 and 8.85 for control and CrP-supplemented sows, respectively). Because sows had similar lactation feed intake and their pigs had similar birth weights (3.07 vs 3.10 for control and CrP supplemented sows, respectively), the lack of a litter size response at weaning was likely due to a management or facility constraint rather than a biological effect related to the dietary treatments. The results add to a body of evidence

that supplementation of biologically available Cr to sows can impact live pigs/litter but realization of those benefits at weaning may depend on additional factors.

Key Words: Swine, Chromium, Reproduction

138 Effect of lower concentrations of copper proteinate compared to copper sulfate on nursery pig growth performance. M. S. Carlson¹, C. Wu^{*1}, A. Tsunoda¹, D. W. Bollinger¹, T. L. Veum¹, and G. W. Tibbetts², ¹University of Missouri, Columbia, MO, ²Alltech Biotechnology, Inc., Nicholasville, KY.

The objective of this experiment was to evaluate lower levels of an organic source of copper (Cu) as Cu proteinate (Bioplex Cu, Alltech Biotechnology, Inc. Nicholasville, KY), compared to 250 ppm of inorganic Cu as CuSO₄, with pig growth performance for 28 days post-weaning as the criteria. One hundred twenty six pigs were weaned at 17 ± 2 days of age (6.36 ± .017 kg) and allotted to dietary six treatments based on weight, sex, and ancestry. Pigs were housed in an environmentally regulated building with 3 pigs/pen (1.2 × 1.2 m) and 7 pens(replications)/treatment. The Phase I (d 1 - 14) Basal diet was formulated to contain 22.5 % CP, 1.5 % total lysine, and .42 % methionine. The Phase II (d 15 - 28) Basal diet contained 20.9 % CP, 1.25 % total lysine, and .37 % methionine. The Phase I and Phase II Basal diets contained 165 ppm Zn as ZnSO₄, 165 ppm Fe as FeSO₄, and 16.5 ppm Cu as CuSO₄. The six dietary treatments were (1) Basal diet, (2) Basal + 25 ppm Cu as Bioplex Cu, (3) Basal + 50 ppm Cu as Bioplex Cu, (4) Basal + 100 ppm Cu as Bioplex Cu, (5) Basal + 200 ppm Cu as Bioplex Cu, and (6) Basal + 250 ppm Cu as CuSO₄. Pigs remained on the same treatments for the entire 28-d experiment. During wk 1, pigs had a linear increase ($P \leq .05$) in ADG with increasing concentrations of Bioplex Cu, with pigs fed the diet containing 200 ppm Cu as Bioplex Cu having the highest ADG ($P \leq .05$). During Phase II and overall, growth performance criteria were higher ($P \leq .05$) for pigs fed the diet containing 50 ppm Cu as Bioplex Cu compared to pigs fed the diet containing 250 ppm Cu as CuSO₄. In conclusion, feeding 50 ppm Cu as Bioplex Cu improved pig growth performance during the first four weeks post-weaning.

Key Words: Pigs, Copper, Growth

139 Effect of lower concentrations of zinc proteinate compared to zinc oxide on nursery pig growth performance. M. S. Carlson¹, C. Wu¹, A. Tsunoda^{*1}, D. W. Bollinger¹, T. L. Veum¹, and G. W. Tibbetts², ¹University of Missouri, Columbia, MO, ²Alltech Biotechnology, Inc., Nicholasville, KY.

The objective of this experiment was to evaluate lower levels of an organic source of zinc (Zn) as Zn proteinate (Bioplex Zn, Alltech Biotechnology, Inc. Nicholasville, KY), compared to 2,000 ppm of inorganic Zn as ZnO, with pig growth performance for 28 days post-weaning as the criteria. Ninety eight pigs were weaned at 17 ± 2 days of age (5.27 ± .07 kg) and allotted to dietary six treatments based on weight, sex, and ancestry. Pigs were housed in an environmentally regulated building with 2 pigs/pen (.6 × 1.2 m) and 7 pens (replications)/treatment. The Phase I (d 1 - 14) Basal diet was formulated to contain 22.5 % CP, 1.5 % total lysine, and .42 % methionine. The Phase II (d 15 - 28) Basal diet contained 20.9 % CP, 1.25 % total lysine, and .37 % methionine. The Phase I and Phase II Basal diets contained 165 ppm Zn as ZnSO₄, 165 ppm Fe as FeSO₄, and 16.5 ppm Cu as CuSO₄. The seven dietary treatments were (1) Basal diet, (2) Basal + 50 ppm Zn as Bioplex Zn, (3) Basal + 100 ppm Zn as Bioplex Zn, (4) Basal + 200 ppm Zn as Bioplex Zn, (5) Basal + 400 ppm Zn as Bioplex Zn, (6) Basal + 800 ppm Zn as Bioplex Zn, and (7) Basal + 2,000 ppm Zn as ZnO. Pigs remained on the same treatments for the entire 28-d experiment. During wk 1 to 2, pigs fed the diet containing either 50 or 100 ppm Zn as Bioplex Zn and 2,000 ppm Zn as ZnO had the greatest growth performance ($P \leq .05$). Over the entire 28-d study, pigs fed the Basal diet, any of the Bioplex Zn treatments (50, 100, 200, 400 or 800 ppm Zn) or 2,000 ppm Zn as ZnO had similar ($P \geq .10$) ADG, ADFI, and feed efficiency. In conclusion, feeding 50 or 100 ppm Zn as Bioplex Zn, or 2,000 ppm Zn as ZnO to pigs weaned at 17 days of age improved growth performance during the first two weeks post-weaning. These results suggest that 50 or 100 ppm Zn as Bioplex Zn may replace 2,000 ppm Zn as ZnO based on 28-d growth performance in the nursery.

Key Words: Pigs, Zinc, Growth

140 Iron bioavailability of an iron-amino acid chelate. B. K. Anderson^{*1}, N. R. Augspurger¹, M. Ellis¹, and D. E. Nuzback², ¹University of Illinois at Urbana-Champaign, ²Albion Laboratories, Inc..

The objective of this study was to determine the bioavailability of iron (Fe) in an iron-amino acid chelate (IAAC; Albion Laboratories, Inc.) in pigs of 5 to 10 kg live weight. A depletion/repletion study involving 72 pigs from eight litters of Line 326 × Camborough 22 pigs (Pig Improvement Company, Franklin, KY) was conducted. Piglets received no supplemental Fe and were weaned at an average of 21 .8 days of age at an average weaning weight of 5.32 .85 kg. Post-weaning, pigs were moved to plastic nursery pens and randomly assigned to treatment from outcome groups formed on the basis of litter and weight. Diets were based on dried skim milk and corn with the common basal diet containing 27 mg/kg Fe. Experimental diets were formulated from aliquots of the basal diet to have incremental additions of 25, 50, 75, and 100 mg/kg Fe via substitution of corn starch with either ferrous sulfate or IAAC. Pigs were given ad libitum access to their assigned diet for 21 days and feed disappearance and weight gain recorded. Blood samples were obtained by jugular puncture at the start and end of a 21-day study period and hemoglobin (Hb) concentration was measured colorimetrically. Average daily gain increased significantly ($P < .001$) as dietary iron concentration from both supplemental iron sources increased. Final plasma hemoglobin concentrations increased as dietary iron concentrations increased for both iron sources ($P < .001$). The regression of final hemoglobin (g/dl) and average daily iron intake (g/d) was determined to be linear (Ferrous sulfate: $Y = 3.215295$ ($SE = .56697239$) + .077693 ($SE = .01658785$) * Iron intake; $R^2 = .3853$; $P < .001$. Iron chelate: $Y = 3.182134$ ($SE = .41221838$) + .075796 ($SE = .01130391$) * Iron intake; $R^2 = .5694$; $P < .001$). The calculated bioavailability of the IAAC, based on the slope ratio for the iron chelate and ferrous sulfate was 97.56% of ferrous sulfate. This suggests that the bioavailability of Fe from the iron amino acid chelate evaluated in this study was relatively high compared to ferrous sulfate.

Key Words: Pigs, Iron, Bioavailability

141 Maximizing digestion of meat and bone meal *in vitro* with minimal enzymes. Y. Qiao^{*}, J. Koger, and T. van Kempen, North Carolina State University.

A quality control technique to assess the digestible amino acid contents of meat and bone meal (MBM) under routine conditions is being developed. This technique will be based on an *in vivo* validated two-stage *in vitro* digestibility assay designed to maximize digestion of MBM *in vitro* while minimizing the use of exogenous digestive enzymes. The objective of this *in vitro* study was to define the time of digestion and the amount and frequency of enzyme applications. Briefly, MBM was first digested with different pepsin levels (PP, ratio to protein) at pH 4.0 and then with a pancreatin and trypsin mixture (PT, pancreatin/trypsin=6/1, ratio to protein) at pH 7.0. The digestion was monitored by the OPA method of Church et al. (1983). Kinetic studies of PP showed that the time needed for the digestion to reach 95% of plateau was 6.5, 9.5, 13.5, 30.0 and 34.5 h for 10%, 4%, 1%, 0.5% and 0.25% of PP, respectively. The time needed for PT at 4% was 19 or 20 h, following PP at 0.25% or 1% respectively, while for PT at 1% or 0.25% following PP at 0.25%, it was 30 or 38 h. Compared with PT, PP's contribution to digestion was minor (15% on average). In order to keep the experiment manageable, treatment time of 24 h for PP and 48 h for PT was chosen for the subsequent experiments. It was found that no improvement of digestibility was obtained by splitting 1% of PP ($p = 0.228$) or PT ($p = 0.313$) into several doses over a sufficiently extended period of time. Therefore, a single dose administration should be preferred. To determine optimum enzyme levels, a surface response of different PP and PT combinations was obtained through a 7 X 9 factorial design. The results suggest that PT was essential and PP was not indispensable to achieve maximal digestion, and the interact between PP and PT was not observed. It was concluded that maximal digestion of MBM could be achieved with minimal enzyme levels of 0.25% PP for 24 h and 4% PT for 48 h. On a protein base, the total enzymes thus used were 2.6% of MBM protein. At this level, enzymes minimally confound the *in vitro* measurement of digestible amino acids in MBM.

Key Words: Meat and Bone Meal, In Vitro Digestibility, Protein

142 Effect of high intensity sweetener level on nursery pig performance. K.W. Purser*¹, T.L. Ward², and D. Felisa³, ¹Prince Agri Products, Inc., Quincy, IL, ²Consolidated Nutrition, L.C., Decatur, IN, ³Pancosma S.A., Geneva, Switzerland.

Pigs (170 PIC 326 x C22, weaned at 15.8 d, 5.1 kg) were used to determine the effect of inclusion level of a high intensity sweetener (HIS, SUCRAM [trademark of Pancosma S.A.]) on ADFI and ADG during the nursery phase. The experiment utilized a randomized complete-block design consisting of five dietary treatments (TRT) with seven weight replicates per TRT. A four-stage nursery program was used with pigs fed the same basal diet within each stage. Dietary TRT for TRT 1-5, respectively, were obtained by adding 0, 7, 14, 21, 28% equivalent sucrose (ES) from HIS in Stages 1 (0-6 d) and 2 (7-13 d); 0, 4, 8, 12, 16% ES in Stage 3 (14-26 d); and 0, 2, 4, 6, 8% ES in Stage 4 (27-39 d). During stage 1, inclusion of HIS increased ADFI (linear effect, $P < .10$) and ADG (linear effect, $P < .05$). This effect was most pronounced at the two highest levels of HIS (145, 135 and 149, 129 g/d for ADFI and ADG at 21 and 28% ES vs 124, 98 g/d for 0% ES, respectively). Feed:gain ratio (F/G) was not affected ($P > .10$) by HIS. For stage 2, HIS did not affect ($P > .10$) ADFI, ADG, or F/G. However, pigs fed HIS maintained the higher BW (linear effect, $P < .01$) achieved in stage 1. Results from stage 3 demonstrated a cubic effect ($P < .10$) of HIS use on ADG with pigs fed 12% ES gaining fastest (493 vs 457 g/d for pigs fed 12 and 0% ES, respectively). Similarly, a cubic effect ($P < .05$) of HIS was observed in stage 4 with pigs fed 2 and 4% ES having the greatest ADG (589, 587 vs 551 g/d for 2, 4 and 0% ES, respectively). When measured over the entire study, HIS did not affect ($P > .10$) ADFI, ADG or F/G. These data suggest that use of HIS can increase ADFI and ADG in the initial stage postweaning. Interestingly, the sum of maximum improvements observed in ADG with HIS addition during each stage resulted in a total increase in ADG of 1.3 kg compared to pigs fed 0% ES. This observation suggests that selecting the optimal level of HIS addition for each nursery stage may offer potential to improve ADG during the entire nursery phase.

Key Words: Pig, Sweetener, Sucrose

143 Effects of an isolated *Lactobacillus* on growth performance of weaning pigs. J. C. Whisenhunt*, S. D. Carter, S. E. Gilliland, R. W. Fent, and M. Rincker, Oklahoma State University, Stillwater.

Seventy-five pigs were used to determine the effect of *Lactobacillus acidophilus* L23 administration on weaning pig performance. *Lactobacillus acidophilus* L23 was isolated originally from pig feces and was selected for its amylase activity. Pigs (6.5 kg, 20-d of age) were randomly allotted to 3 treatments (4 pens/trt of 6-7 pigs/pen) based on weight, sex, and litter. All pigs were fed a simple corn-soybean meal diet in two dietary phases (Phase 1, d 0-21; Phase 2, d 21-35). Low lactose (<1%), whey protein concentrate was utilized in Phase 1 as an amino acid source. Feed and water were offered ad libitum. Treatments included a control group which were given 10 mL of non-fat milk. In Treatment 2, pigs were administered 10 mL of non-fat milk containing approximately 3×10^8 (Low) cells of *L. acidophilus* L23. Treatment 3 consisted of pigs administered 10 mL of non-fat milk containing approximately 3×10^9 (High) cells of *L. acidophilus* L23. The *lactobacilli* were mixed with the milk and administered orally to each pig. All pigs were dosed every 24 h with a 12-mL syringe. Pigs and feeders were weighed weekly to determine rate and efficiency of gain. For Phase 1, ADG, ADFI, and G/F were, respectively: 114, 132, 135 g; 205, 207, 215 g; and .556, .638, and .627. Pigs administered low and high concentrations of *L. acidophilus* L23 had greater ($P < .07$) ADG and G/F compared with pigs receiving the control. There were no differences among treatments in Phase 2 (d 21-35). Over the 5-wk experimental period, pigs administered *L. acidophilus* L23 grew faster ($P < .06$) than control pigs and tended to have improved ($P < .11$) G/F compared with control pigs. Pigs receiving the low dose showed similar ($P > .10$) responses to pigs given the high dose throughout the experiment. The administration of *L. acidophilus* L23 to weaning pigs improved growth rates and feed utilization in the nursery phase. Low concentrations appear to be as effective as high concentrations in eliciting a growth response in young pigs.

Key Words: Pigs, *Lactobacillus*, Growth

144 The effect of dried bacterial cell powder on growth performance in nursery pigs. K Watanabe*¹, Y Toride¹, J.L. Usry², and D.J. Burnham², ¹Ajinomoto Co, Inc., ²Heartland Lysine, Inc., Chicago, IL.

Digested bacterial cell powder (DBCP) was prepared from *Brevibacterium lactofermentum* as an immunopotentiator containing peptidoglycan. A study was conducted to determine the effect of dietary supplementation of DBCP on average daily gain (ADG), average daily feed intake (ADFI), feed efficiency (F/G), and medication use in a commercial swine nursery. A total of 440 pigs weaned at 16 to 21 days of age were visually sorted by size into five replicates by weight within sex (22 barrows or 22 gilts/pen). Pen weights were determined within replicate (5 pens of gilts and 5 pens of barrows/ treatment). Pigs were fed either control diets or a control diet supplemented with 0.05 % DBCP. Experimental diets contained corn, SBM, whey, fishmeal, and blood meal, and were formulated to contain 1.59 % Lys with 3,472 kcal/kg ME, 1.45 % Lys with 3,263 kcal/kg ME, and 1.37 % Lys with 3,338 kcal/kg ME, for Phase 1 (7 days), 2 (8 days), and 3 (15 days), respectively. Pen weight and feed consumption were measured and F/G was calculated at the end of each dietary phase. Pigs were observed and scored for clinical signs of diarrhea. Scours are treated, at the discretion of the manager, with a 2 cc injection of Polyflex. Pigs exhibited severe scours beginning 3 days postweaning and the presence of *Salmonella* sp. was confirmed as the infectious organism. Pigs on the 0.05% DBCP treatment had the firmest scour score ($P < 0.01$) in phase 1 and exhibited very little scouring compared to pigs in the control group. ADG was similar between treatments, for the entire nursery period. However, pigs on the 0.05% DBCP treatment had lower mortality (0.00% vs. 2.00%; $P < .03$) and required the fewest injections of Polyflex (n/pen: 6.80 vs. 22.40 ; $P < .001$) versus the control. These results suggest that supplementing with DBCP in nursery pig diets improves resistance to diarrhea caused by salmonella sp., which in turn improves growth performance and may reduce medication costs in the nursery.

Key Words: nursery pigs, diarrhea, immune status

145 Effects of pelleting and storage of a complex nursery pig diet on lysine bioavailability. I. Mavromichalis* and D. H. Baker, University of Illinois at Urbana-Champaign.

The effects of pelleting and storage of a complex nursery pig diet (28% lactose and 1.4% total lysine) on lysine bioavailability were assessed in a chick bioassay. The pig nursery diet was steam-conditioned at 60 °C for 45 s and then pelleted through a 5-mm die with a depth of 38 mm. Samples of meal and pelleted diets were placed in metallic feeders in an occupied nursery facility for 1 wk (warm) or were stored at 4 °C (cool). For the standard-curve bioassay, a total of 144 8-d-old chicks were offered the following dietary treatments: 1 to 3) a basal diet (lysine deficient) and two levels (.08 and .16%) of added lysine (from L-Lysine-HCl); 4 and 5) two positive controls (.7% added lysine with or without 10% of the nursery diet); and 6 to 9) basal diet plus 10% of one of the four nursery diet samples (meal or pellet stored cool or warm for 1 wk). Pelleting had no effect ($P > .10$) on lysine bioavailability, probably because pelleting conditions (temperature, humidity, and pellet size) were not aggressive enough to result in detectable effects on lysine utilization. However, storage in the nursery facility for 1 wk reduced ($P < .03$) lysine bioavailability by an average of 10%. No significant ($P > .10$) interactions were observed. Furthermore, true digestibility of lysine in the four pig diet samples was estimated in a cecectomized cockerel digestibility assay using fifteen adult Single-Comb White Leghorn cockerels. Lysine digestibility in all samples was high (avg of 94%) and was not affected ($P > .10$) by treatment. We conclude that the pelleting conditions used in our experiments did not decrease lysine utilization. More research is needed to define thermal processing conditions that might cause protein quality deterioration. On the contrary, typical warm and humid environmental conditions encountered in modern nursery facilities have a negative effect on protein quality of diets rich in reducing sugars and lysine.

Key Words: Nursery pigs, Pelleting, Storage

146 Nutritional strategies to lower pig starter feed costs among differing grain energy sources. D. G. Landblom* and W. W. Poland, *Dickinson Research Extension Center, North Dakota State University, Dickinson, ND.*

Four experiments were conducted using 19-21 d pigs ($n = 410$; $BW = 5.5 \pm .43$ kg) to evaluate progressively lower cost Phase-1 pig starter formulations and energy substrates on postweaning pig performance during an initial d 0-7 transition and over a 28-day feeding period. The four experimental preparations: Diet1, 22% dried whey (DW), 7.5% lactose (L), and 6% spray-dried animal plasma (SDAP); Diet2, 22%DW, 7.5%L, 2%SDAP, 2% soy protein conc.(SPC), and 2% spray dried blood meal (SDBM); Diet3, 29%DW, 4.5%SDAP, Diet4) 29%DW, 1.5%SDAP, 2%SPC, and 1%SDBM were fed in corn(C)-, hull-less waxy barley(HWB)-, hull-less oat(HO)-, and hard red spring wheat(HRSW)-based diets in separate experiments and compared to a corn control diet containing 22%DW, 7.5%L, and 6%SDAP. Transitional preparations fed during Phase-1 (0-7d) were significantly reduced in Phase-2 (8-14d), and entirely removed in Phase-3. Pigs were assigned to 4 pen replicates/diet and 7 or 8 pigs/pen. Phase-1 and -2 diets were pelleted, and Phase-3 diets were fed in meal-form. Initial (0-7d) inclusion of either 4.5 or 6.0% SDAP or the DW+L combination stimulated ADFI ($P=.03$), and G:F ($P=.07$) when C and HWB were the basal grains. By contrast, when HO and HRSW were the basal grains, d 0-7 pig response was numerically better for all test diets compared to controls. Highest levels of SDAP did not stimulate ADG, ADFI, or G:F more than the lower cost protein and lactose combinations. For the 28-d period, pigs fed Diet 4 and HO were more efficient ($P=.01$), and those receiving Diet 4 and HRSW grew faster ($P=.01$), consumed more ($P=.01$), and were the lowest cost/unit of gain to feed compared to the control and other test diets. These data suggest, nutrient-dense, pig starter diets prepared with each of the four test diets, and either HO or HRSW basal grains, support diet transition and 28-day pig growth without weaning lag.

Key Words: Pig starter, Protein combinations, Energy source

147 Blend-feeding regimens for nursery pigs. I. Mavromichalis*, C. M. Peter, and D. H. Baker, *University of Illinois at Urbana-Champaign.*

Up to five complex diets may be used in phase-feeding regimens to accommodate the rapidly changing requirements of nursery pigs. Several of these diets must be fed manually because quantities are too small to be effectively handled by most automatic systems. Moreover, to avoid frequent manual feedings, large quantities of these heat-sensitive diets are placed in feeders with detrimental effects on lysine bioavailability. The objective of this study was to develop a feeding regimen with two diets blended at different ratios that would be compatible with mechanization. Seventy-five pigs with an average initial weight of 5.5 kg were randomly assigned (5 replicates/treatment and 5 pigs/pen) in three feeding regimens. Pigs under the control 3-phase feeding regimen (3P) were offered a complex diet (A) for the first wk postweaning, a semi-complex diet (B) for wk 2 and 3, and a simple diet (C) for wk 4 and 5. In the two blend-feeding regimens (BF1 and BF2), diets A and C were blended in different ratios. In BF1, pigs were offered: 100%A (wk 1); 75%A:25%C (wk 2); 50%A:50%C (wk 3); 25%A:75%C (wk 4); and 100%C (wk 5). In BF2, pigs were offered: 100%A (wk 1); 67%A:33%C (wk 2); 33%A:67%C (wk 3); and 100%C (wk 4 and 5). All diets were pelleted (5 mm). Overall weight gain, feed intake, and feed efficiency were not affected by any of the feeding regimens ($P > .15$). In fact, pigs in BF1 and BF2 grew faster ($P < .05$) during the second wk compared to pigs in 3P. Although consumption of diet A was higher in BF1 and BF2 than in 3P, it appears that more aggressive blend-feeding regimens might be feasible because growth depressions were not observed in BF2. These results suggest that blend-feeding regimens can support maximal performance with only two diets. The flexibility of this practice at the farm level would appear to offer advantages over typical programs that may require three or more diets.

Key Words: Nursery Pigs, Phase Feeding, Blend Feeding

148 Optimum threonine:lysine ratio in a corn-soybean meal diet for pigs in the late nursery phase (12-23 kg). M. E. Johnston*¹, D. R. Cook², R. D. Boyd¹, K. D. Haydon³, and J. L. Usry⁴, ¹PIC USA Inc., Franklin, KY, ²Akey Inc., Lewisburg, OH, ³Heartland Pork, Alden, IA, ⁴Heartland Lysine Inc., Chicago, IL.

The objective of this study was to determine the growth response of nursery pigs (11.8 to 23.0 kg BW) fed corn-soy diets limited in soybean meal (29.5%) with varying threonine:lysine (Thr:Lys) ratios. Eight hundred eighty barrows and gilts (40 pens with 22 pigs/pen) were sorted by weight and randomly allotted to one of four dietary treatments (11.8±0.4 kg, 220 pigs/treatment). A single source of corn and soybean meal was used to make all diets. In addition, amino acid analysis was done on both ingredients prior to formulation of the diets. In all diets, L-lysine HCl was used to bring the true ileal digestible (TID) lysine content to 1.11% and DL-methionine was used to keep the TID methionine+cystine:Lys ratio at 60%. Diets were formulated to contain 3316 kcal ME/kg. Synthetic threonine was added to the diet at 0, 0.05, 0.10, and 0.15% to give TID threonine levels of 0.60, 0.65, 0.70, and 0.75%. This resulted in TID Thr:Lys ratios of 54, 59, 63, and 68% for diets 1, 2, 3, and 4, respectively. Response criteria included ADG, ADFI, feed efficiency (GF), and cost/kg of gain. There was a linear improvement in ADG (494, 519, 519, 525 g/d) with increasing threonine levels ($P<.01$). ADFI increased as threonine increased in the diet (734, 742, 743, 757 g/d, linear $P<.05$). Feed efficiency improved in a quadratic manner ($P<.05$) as synthetic threonine increased from 0 to 0.15% (0.67, 0.70, 0.70, and 0.69). Likewise, there was a quadratic improvement in cost/kg of gain with increasing threonine addition (\$0.331, \$0.322, \$0.324, \$0.331, $P<.05$). These data indicate that ADG and ADFI are maximized at a TID Thr:Lys ratio of 68% but optimum GF and cost/kg of gain were obtained at a TID Thr:Lys ratio of 59%. Based on the threonine response curve, the TID Thr:Lys ratio that optimized GF and cost of gain was less (59 to 63%) than required to optimize ADG.

Key Words: Pigs, Threonine, Nursery phase

149 Effect of reduced dietary crude protein with supplemented crystalline amino acids on manure odors of growing pigs. E.R. Otto*, M. Yokoyama, S. Hengemuehle, and N.L. Trottier, *Michigan State University, East Lansing, MI.*

A study investigating the effect of dietary crude protein (CP) reduction with crystalline amino acids (CAA) supplementation in growing pigs on manure slurry odor was conducted. Six crossbred barrows (initial BW 44.67 ± .76 kg) in a 6 x 6 Latin square were used to test six CP + CAA dietary treatment combinations. Treatments (TRT) were: 15% CP (A), 12% CP+CAA (B), 9% CP+CAA (C), 6% CP+CAA (D), 15% CP casein (E) and protein-free (F). Total feces and urine were collected over a 5-d period and pooled within pig and period. Samples of pooled feces and urine were mixed in a 1:5 ratio (fecal wt/urine vol), stored and fermented at room temperature (21°C) for 28d. Cotton balls were placed into vials, and saturated with 10-mL fermented slurry samples and capped. Slurry sample sets were double randomized before sniffed. Six replicates per treatment were prepared for human panelists. Every sample set contained all six treatments. This was repeated six times corresponding to the respective fecal and urinary collection period. Total of 34 subjects (12 females, 22 males) participated throughout the six repetitions, yielding 436 observations. Subjects sniffed each sample and documented the odor offensiveness. Odor offensiveness was classified on severity 1 - 5: (1) non-offensive, (2) mildly offensive, (3) moderately offensive, (4) strongly offensive, and (5) extremely offensive. Responses are ordered with lower classification being less offensive. Responses were marked following the sniffing of each sample. Data were analyzed using the GENMOD procedure, which allows assessment of differences in the classification for TRT. Estimates with significant differences ($P<.05$) between TRT are reported as log odds ratios. Comparison of TRT A to TRT D and TRT B to TRT D indicated that the odds of TRT A and TRT B being in lower offensiveness category as TRT D were 2.41 and 1.79, respectively. Comparison of TRT D to TRT F indicated that TRT D was .51 times more likely to be in a lower classification than TRT F. These results imply that dietary treatments with lower CP do not reduce odor offensiveness.

Key Words: pigs, odor panel

150 Sulfur amino acid to lysine ratio that optimizes performance in growing pigs. M. E. Johnston^{*1}, R. D. Boyd¹, and J. L. Usry², ¹PIC USA Inc., Franklin, KY, ²Heartland Lysine Inc., Chicago, IL.

This study was designed to determine the proper ratio of total sulfur amino acids to lysine in diets and to investigate the effect of an excess on feed conversion (GF) and ADG for growing pigs (54 to 83.5 kg). Sixty-four PIC 327 x C22 gilts were allotted on the basis of weight and backfat to one of eight diets and penned individually (1.39 m²/pig). The control diet contained corn and soy (17% CP, 0.81% true ileal digestible Lysine (TIDLys)) and was formulated to meet or exceed the requirement for optimum lean deposition and had a TID sulfur amino acid (SAA):Lys ratio of 65% (TIDSAA of 0.53%). A negative control diet was formulated using corn and soy as the only amino acid source (15% CP, 0.64% TIDLys, 0.47% TIDSAA). The remaining six dietary treatments had TIDSAA levels of 0.47, 0.42, 0.40, 0.38, 0.36, and 0.34%. Nitrogen (2.34%), CP (14.45%), and TIDLys (0.64%) were held constant in all six diets. The TIDSAA to Lys ratio ranged from 0.54 to 0.73. Indispensable and dispensable amino acids were held constant through the use of synthetic amino acids. Pigs fed the control diet tended (P>.10) to grow faster (1.11 vs 0.99 kg/d), deposit more whole body protein (148 vs 136 g/d) and less body lipid (280 vs 297 g/d) than negative control pigs. GF improved by 8.7% (P<.06) as TIDSAA to Lys ratio declined from .73 to .54. ADG also improved (P<.05) as the ratio decreased. ADFI, change in backfat depth, and daily protein and lipid accretion rates were not affected (P>.10) by changing the TIDSAA to Lys ratio. The fact that GF was compromised with over-fortification of SAA, while body composition (protein:lipid ratio) was not altered suggests a significant cost in the metabolism of excess nitrogen. The apparent optimum for the TIDSAA to Lys ratio is .54 to .57. This is in agreement with the NRC (1998) for total, TID and apparent SAA:Lys for pigs with an ADG of 1150 g/d and protein accretion of 160 g/d.

Key Words: Pigs, Sulfur amino acids, Finish phase

151 Valine requirement for 10- to 20-kg pigs. I. Mavromichalis^{*} and D. H. Baker, *University of Illinois at Urbana-Champaign.*

Research from our laboratory indicated that beyond Lys, Val is a second co-limiting amino acid in diets for 10-kg pigs, although current estimates place it fifth in order of limitation. It is hypothesized, therefore, that the present Val requirement and (or) its ratio to Lys are inaccurate for high-lean gain nursery pigs. To estimate the Val requirement of 10- to 20-kg pigs, a Val-deficient diet (.55% calculated true ileal digestible Val) that was based on corn, simple sugars, whey, peanut meal, gelatin, and crystalline amino acids was developed and validated in a 14-d growth assay. A total of 60 pigs (4 pigs/pen and 5 replicates/treatment) with an average initial weight of 10.7 kg were randomly assigned to receive: 1) a complex nursery diet that served as a positive control; 2) the Val-deficient basal diet; and 3) the basal diet with .50% L-Val. Weight gain and efficiency of feed utilization were depressed (P < .05) in pigs offered the basal diet compared to the performance of pigs offered the positive control diet. However, performance was restored (P < .05) when the basal diet was supplemented with crystalline Val. In Exp. 2, a total of 120 pigs (4 pigs/pen and 5 replicates/treatment) with an average initial weight of 10.7 kg were used in a 16-d Val titration assay. Pigs were offered the basal diet or the basal diet supplemented with graded doses (.05%) of L-Val to achieve six concentrations of true ileal digestible Val, from .55 to .80%. Pen means data were fitted to a second-degree polynomial model (requirement set at 90% of the upper asymptote) and also to a broken-line model. The true ileal digestible Val requirement for weight gain was calculated to be .76% of the diet or 6.2 g/d. Feed efficiency was optimal at .72% of the diet or at 5.9 g/d. Assuming that these pigs had a Lys requirement of 1.01%, then the Val to Lys ratio is calculated to be 75 and 71% for gain and feed efficiency, respectively. The National Research Council proposed in 1998 a true ileal digestible valine requirement of .69% and a ratio of 68%. It appears that the Val requirement for fast-growing nursery pigs is higher than presently estimated.

Key Words: Nursery Pigs, Valine Requirement, Amino Acids

152 Protein-amino acid utilization in soybean meal for young chickens and pigs as affected by microbial phytase. C. M. Peter^{*}, T. M. Parr, and D. H. Baker, *University of Illinois at Urbana-Champaign.*

Two experiments were conducted to evaluate the effects of microbial phytase (MP) on protein utilization in soybean meal (SBM) fed to young

chicks and nursery pigs, using growth performance as the response criterion. In assay 1, 192 broiler chicks were fed graded levels of protein (5, 10, and 15% CP) furnished by SBM in the presence and absence of 1200 U/kg MP so that the effects of MP on slope-ratio protein efficacy could be assessed. Each of the dietary treatments was fed to eight groups of four chicks from 8 to 21-d posthatching. At assay termination, four groups/treatment were analyzed for whole-body protein. Sixteen chicks were also analyzed at assay initiation to establish initial body protein. Weight gain, gain:feed, and protein accretion were then regressed on CP intake so that multiple linear regression analysis could be performed. Slope-ratio methodology was then applied to evaluate protein utilization as affected by MP. Weight gain, gain:feed, and body protein accretion increased linearly (P < .01) as a function of protein intake, but MP supplementation did not increase (P > .10) the slopes of the accretion curves. In assay 2, 64 pigs with an average initial weight of 10.6 kg were fed two levels of protein (12 or 24% CP) furnished by SBM in the presence or absence of 1200 U/kg MP. Each of the dietary treatments was fed to four pens of four pigs during a 17-d assay period. Pigs fed 24% CP from SBM had greater (P < .01) weight gain, feed intake, and gain:feed responses than pigs fed 12% CP from SBM, but no differences (P > .10) were observed with the addition of 1200 U/kg MP, regardless of the CP level that was fed. These results indicated that 1200 U/kg MP did not affect protein utilization in SBM fed to young chickens or pigs as assessed by growth assays.

Key Words: Soybean Meal, Phytase, Protein Quality

153 The interaction between hydrolyses time and acid concentration affects the measurement of amino acids in soybean meal and ileal digesta from growing pigs. M. R. Smiricky^{*}, J. E. Wubben, D. M. Albin, E. Munger, and V. M. Gabert, *University of Illinois, Urbana, IL.*

Accurate determination of amino acid (AA) levels in soybean meal (SBM) and ileal digesta facilitates optimum diet formulation, AA supplementation and measurement of digestibilities. A study was carried out to investigate the effect of hydrolysis time and acid concentration on AA levels in a sample of SBM (55.48% CP, DM) and in a sample of ileal digesta. The digesta (freeze dried, 19.28% CP, DM) were obtained from a pig fed a corn starch-sucrose diet containing the SBM (17% CP, as fed). Hydrolyses, in duplicate, was carried out in 1, 2, 3, 4.5, 6, 7.5, 9, 10.5 or 12 M HCl in an oven at 110 °C for 2, 4, 6, 10, 24, 48, 72, 96 or 120 h in screw-capped tubes. Pre-column derivatization with phenyl isothiocyanate and HPLC were used to measure AA. Three dimensional plots were constructed using the PROC G3D procedure of the SAS Institute, Inc. Correction factors were calculated to standardize AA levels to 6 M HCl and 24 h hydrolyses. For each AA in SBM and digesta, levels increased as hydrolyses time (P < .0001) and acid concentration (P < .0001) increased. For each AA in SBM and digesta there was an interaction (P < .01) between hydrolyses time and acid concentration. In SBM, lysine level was highest (P > .05) after 10 h of hydrolyses in 12 M HCl (3.39% DM); the correction factor was 1.07. Threonine level in SBM was highest (P > .05) after 48 h of hydrolyses in 4.5 M HCl (2.48% DM); the correction factor was 1.07. Substantial degradation occurred for serine, threonine, arginine (digesta only), tyrosine, phenylalanine (digesta only) and lysine (digesta only) as hydrolyses time and acid concentration increased. Longer hydrolyses times and higher acid concentrations were needed to maximize valine level. The correction factors for serine, tyrosine and valine in SBM and digesta were 1.10 and 1.19, 1.23 and 1.16, and 1.30 and 1.30, respectively. In conclusion, hydrolyses time and acid concentration are important factors that affect AA levels in SBM and ileal digesta.

Key Words: Amino acids, Soybean meal, Ileal digesta

154 Wheat screenings, field peas, and canola seed as replacements for corn and soybean meal in diets for growing-finishing pigs. R. L. Harrold^{*1}, D. Landblom², W. W. Poland, Jr.², and K. B. Miller¹, ¹NDSU, Fargo, ²NDSU, Dickinson.

Two experiments were conducted with growing-finishing pigs (from approximately 20 to 114 kg.) to determine the effects of adding wheat screenings (WS) to mash-type diets based upon corn and SBM (C-S) when the diets also contained field peas (FP) and ground canola seed (GCS). A pelleted C-S diet was used for reference in each of the three phases of the study. The control diets (0% WS) in each phase contained 20% FP and 7.5% GCS seed while diets containing WS contained 20% FP and 15% GCS. Inclusion levels of WS were 0%, 20%, 40%, or 60%.

Diets were prepared at one site and were formulated to contain equal levels of CP, LYS, MET+CYS, THR and TRP within each dietary phase. WS contained 47.49% green and yellow foxtail, 32.82% wheat, 8.72% straw and chaff, 7.84% wild oats, and 3.13% wild buckwheat seeds. Pigs at Site 1 were housed in a modified open front facility while pigs at Site 2 were in confinement. There were three replications of 7 pigs per pen at Site 1 and four replications of 8 pigs per pen at Site 2. ADG (g), ADFI (kg), and F:G values at Site 1 were: 931, 2.43, and 2.61; 905, 2.73, and 3.01; 864, 2.80, and 3.24; 836, 2.85, and 3.41; and 864, 3.15, and 3.64 for the C-S, 0% WS, 20% WS, 40% WS, and 60% WS diets, respectively. Performance values at Site 2 were: 900, 2.22, and 2.48; 850, 2.19, and 2.58; 836, 2.17, and 2.60; 855, 2.28, and 2.67; and 827, 2.35, and 2.84 for the C-S, 0% WS, 20% WS, 40% WS, and 60% WS diets, respectively. Substituting WS for C-S in diets containing 20% FP did not alter ADG ($P > .05$) but increased F:G ($P < .001$ at Site 1; $P < .01$ at Site 2). Most carcass measurements were not altered by the substitution of WS into the diets. However, yield and loin depth were reduced by WS at Site 1 and Minolta color scores of L. dorsi were darker at Site 2. DE (kcal/kg dm) values obtained with six pigs at Site 2 were: Corn, 3.701; WS, 3.410; FP, 3.585; and WCS, 3.987. Wheat screenings can represent an effective source of nutrients for growing-finishing pigs in diets containing field peas to provide a portion of the supplemental protein and amino acids. Ground canola seed can provide supplemental protein, amino acids, and energy to diets containing ingredients having DE energy values lower than corn.

Key Words: Growing-Finishing Swine, Wheat Screenings, Field Peas

155 The efficacy of feather meal in improving performance and carcass composition of growing-finishing swine. D. C. Brown^{*1}, J. K. Apple¹, C. V. Maxwell¹, K. G. Friesen², B. Z. deRudas¹, and Z. B. Johnson¹, ¹University of Arkansas, Fayetteville, AR, ²The Pork Group, Division of Tyson Foods, Rogers, AR.

Crossbred barrows and gilts ($n = 132$; BW = 25.43±6 kg) were used to test the effects of dietary incorporation of hydrolyzed feather meal (FM) on ADG, ADFI, and gain-to-feed ratio (G:F), as well as carcass composition, of growing-finishing swine. Pigs were blocked by weight, segregated within blocks into subgroups based on sex and litter, and assigned randomly to 24 pens (5-6 pigs/pen). Pigs were fed a 3-phase dietary program with transitions from starter to grower and grower to finisher when mean block weight reached 36 and 90 kg, respectively. A total of 24 pens were allotted randomly to 1 of 3 dietary treatments: 1) control corn-soybean meal (SBM) starter, grower, and finisher diets devoid of FM; 2) control diets supplemented with 3% FM; or 3) control diets supplemented with 6% FM. Within the FM-treated diets, FM was substituted for SBM on an equal lysine basis at the expense of corn. When the lightest block of pigs averaged 109 kg, all pigs were transported to a commercial pork processing plant and harvested according to industry-accepted procedures. After a 24-h chilling period, carcass fatness measures were recorded, and fabricated into primal cuts. Hams from the left sides were weighed, boxed, shipped to Louisiana State University, and analyzed in a TOBEC unit. Equations for ham and carcass composition included weight, fat measurements, and TOBEC data. During the starter phase, there was a quadratic decrease in ADG ($P \leq .06$) and G:F ($P \leq .05$). However, during the grower phase, there was a trend for G:F to increase linearly ($P = .12$) as FM increased in the diet. Inclusion of FM had no effects ($P \geq .10$) on performance during the finisher phase, or in the overall trial. Although carcasses from pigs fed 3% FM had greater average backfat measurements (quadratic; $P \leq .02$) than carcasses from pigs fed the control diets or diets containing 6% FM, dietary FM had no effect ($P \geq .10$) on ham or carcass composition. These data suggest that substitution of FM for SBM in the diets of growing-finishing swine may improve feed efficiency, especially during the grower phase, without dramatically affecting carcass composition.

Key Words: Growing-finishing Swine, Feather Meal, Carcass Composition

156 Effects of modified tall oil and creatine monohydrate on growth performance, carcass characteristics, and meat quality of growing-finishing barrows. P. R. O'Quinn^{*}, B. S. Andrews, R. D. Goodband, J. A. Unruh, J. L. Nelssen, J. C. Woodworth, and M. D. Tokach, Kansas State University, Manhattan.

Eighty crossbred barrows (initially 45.4 kg) were allotted randomly to one of four dietary treatments by weight and ancestry. The experiment was arranged as a 2 × 2 factorial with two levels of modified tall oil

(MTO; 0 or .50%), which were fed throughout the growing-finishing period, and two levels of creatine monohydrate (CMH; 0 or 25 g/d), which were fed for the final 10 d preslaughter. The corn-soybean meal diets were fed in two phases (45.4 to 78.9 kg and 78.9 to 117.5 kg BW). When CMH was added to the diet in place of corn, average BW was 107.5 kg. Feeding MTO increased ($P < .05$) ADG and gain to feed ratio (G:F) from 45.4 to 78.9 kg and tended to improve ($P = .10$) G:F from 45.4 to 107.5 kg. Dietary treatment did not affect ($P > .15$) growth performance from 78.9 to 107.5 kg. Modified tall oil increased ($P = .02$) G:F during the 10 d CMH supplementation period, and CMH numerically ($P = .11$) increased ADG and G:F. Supplementation of CMH did not affect ($P > .20$) any measured carcass characteristic or measures of meat quality at 24 h or 14 d postmortem. Feeding MTO reduced average backfat (2.70 compared to 2.93 cm, $P = .05$) and 10th rib backfat (2.10 compared to 2.45 cm, $P = .01$) but did not affect ($P > .10$) other measured carcass characteristics or measures of meat quality at 24 h postmortem. Modified tall oil increased ($P = .02$) L* values and tended to increase ($P \leq .10$) thawing and cooking losses of longissimus muscle chops at 14 d postmortem. These data demonstrate that MTO improves growth performance and reduces backfat in growing-finishing pigs, but supplementation of CMH, under the conditions of this experiment, was not beneficial for growing-finishing pigs.

Key Words: Pigs, Modified Tall Oil, Creatine Monohydrate

157 Effects of feeding modified tall oil and supplemental magnesium on growth performance, carcass characteristics, and meat quality of growing-finishing gilts. P. R. O'Quinn^{*}, J. L. Nelssen, J. A. Unruh, R. D. Goodband, J. C. Woodworth, and M. D. Tokach, Kansas State University, Manhattan.

Eighty crossbred gilts (initially 45.8 kg) were allotted randomly to one of four dietary treatments by weight and ancestry. The trial was arranged as a 2 × 2 factorial with two levels of modified tall oil (MTO; 0 or .50%) and two levels of added Mg from potassium magnesium sulfate (K_2SO_4 -2MgSO₄; 0 or 2%). This level of supplemental Mg equated to a daily Mg intake of 7.75 g. The corn-soybean meal diets with and without MTO were fed in two phases (45.8 to 76.2 kg and 76.2 to 118.1 kg BW), and supplemental Mg was added to the diet in place of corn for the final 7 d preslaughter (starting at 114.1 kg BW). Dietary treatment did not affect ($P > .10$) ADG, ADFI, or gain to feed ratio (G:F). Feeding MTO decreased ($P = .05$) average backfat thickness (2.44 compared to 2.62 cm) and increased ($P = .04$) intramuscular marbling. Modified tall oil increased ($P = .02$) calculated percentage lean, (55.19 compared to 53.47%), and Mg supplementation lowered ($P = .04$) longissimus glycogen content. Dietary treatment did not affect ($P > .10$) other carcass characteristics or measures of meat quality such as drip loss, color, or lactic acid content of the longissimus muscle. Feeding MTO tended to increase plasma glucose ($P = .05$) and decrease ($P = .10$) base excess in the extracellular fluid. Feeding Mg tended to decrease ($P < .10$) plasma pH, blood urea nitrogen (BUN), and base excess in the whole blood and extracellular fluid and to increase ($P < .10$) K⁺, ionized Mg⁺⁺, and lactate. These results support earlier research identifying MTO as a potential carcass modifier and contributor to meat composition and quality. Magnesium supplementation altered whole blood profiles and longissimus glycogen content in a manner that should elicit improvements in pork quality, although they were not observed.

Key Words: Pigs, Modified Tall Oil, Magnesium

158 The introduction of conjugated linoleic acid enriched beef tallow into the diet of laying hens. R. Aydin^{*1}, M.W. Pariza², and M.E. Cook^{1,2}, ¹Animal Sciences Department, ²Department of Food Microbiology and Toxicology, University of Wisconsin, Madison.

Conjugated linoleic acid (CLA) is a mixture of positional and geometrical isomers of linoleic acid which has been shown to have many health attributes in humans and animals. However, studies conducted in our laboratory have shown that maternal dietary CLA increased the level of saturated fatty acids in egg yolk, altered interior egg quality, and induced embryonic mortality in various avian species. Since CLA may soon be used as an animal feed supplement, the objective of this study was to determine if feeding laying hens beef tallow from cows fed a CLA-supplemented diet would induce chick embryonic mortality and cause changes in egg quality. Single Comb White Leghorn laying hens (10 per treatment) were fed a diet supplemented with 0.5% canola oil (CO), 0.5% CLA (CLA), 10% regular beef tallow (BT), 0.5% CLA plus 10% regular beef tallow (CLA+BT), 10% beef tallow from cows fed 1%

CLA (BTCLA1), or 10% beef tallow from cows fed 2.5% CLA (BTCLA2.5) for 18 days. Hens were artificially inseminated weekly. Eggs were collected daily, stored at 15C for 24 hrs, and then incubated. Some unincubated eggs were stored at 4C or 21C for 30 days and analyzed for pH and fatty acid content. After the 8th day of feeding CLA alone, embryonic mortality of fertile eggs was 100% versus 7, 9, 5, 6, and 7% in CO, BT, CLA+BT, BTCLA1, and BTCLA2.5, respectively. Total CLA levels of yolk from CO, CLA, BT, CLA+BT, BTCLA1, and BTCLA2.5 were 0, 2.13, .91, 1.56, 1.1, and 1.2%, respectively. CLA and CLA+BT significantly increased C16:0, C18:0 and decreased C16:1(n-7) and C18:1(n-9). Eggs from group BTCLA1 or BTCLA2.5 did not have increased C16:0 and C18:0 or decreased C18:1(n-9) compared to CO. Arachidonic acid content of yolk was significantly reduced by CLA compared to CO. Yolk pH increased and albumen pH decreased in the egg from CLA group relative to CO (8.09 and 8.63 versus 6.13 and 9.04, respectively) when stored at 4C for 30 days. Feeding CLA also caused discoloration of yolk and albumen when whole eggs were stored at 4C for 30 days. Abnormal pH changes and discoloration did not develop in the yolk and albumen of the eggs from CO, BT, CLA+BT, BTCLA1 and BTCLA2.5. These results suggested that beef tallow from cows fed CLA or beef tallow supplemented with CLA had no adverse effect on hatchability or egg quality when fed to laying hens.

Key Words: Beef tallow, Conjugated linoleic acid, hatchability

159 Effect of betaine on growth, carcass traits, and pork quality of finishing pigs. J. O. Matthews*, L. L. Southern, A. D. Higbie, M. A. Persica, and T. D. Bidner, *LSU Agricultural Center.*

An experiment was conducted to determine the effect of dietary betaine (0, .125, .250, or .500%) on growth, carcass traits, pork quality, and tissue betaine concentrations of crossbred finishing pigs. Four replications of three pigs (two barrows and one gilt) each were used. The basal diet contained .85 (69 to 88 kg BW) or .65% Lys (88 to 115 kg BW). Overall ADG and gain:feed were not affected ($P > .10$) by betaine, but overall ADFI was decreased (quadratic, $P < .02$; 0 vs betaine, $P < .01$) by betaine, with pigs fed .250% betaine having the lowest ADFI. Loin muscle area, average backfat, dressing percentage, percentage lean, total fat, lean:fat, and leaf fat weight were not affected ($P > .10$) by betaine. Tenth rib 3/4 backfat thickness was decreased (quadratic, $P < .05$; 0 vs betaine, $P < .02$) in pigs fed betaine. Carcass length was increased (linear, $P < .03$; 0 vs betaine, $P < .06$) as the level of betaine was increased. Fat-free lean, lean gain per day, ham weight, ham fat-free lean, and ham percentage lean were increased (quadratic, $P < .06$) in pigs fed .250% betaine, but percentage fat, total ham fat, percentage ham fat, and butt fat thickness were decreased (quadratic, $P < .06$) in pigs fed .250% betaine. Purge loss and 24 h pH were increased (quadratic, $P < .10$; 0 vs betaine, $P < .02$) and cooking loss was decreased (linear, $P < .03$) in pigs fed betaine. The Minolta L^* value for the *biceps femoris* was decreased (quadratic, $P < .06$; 0 vs betaine, $P < .09$), with pigs fed .250% betaine having the lowest L^* value. Subjective color, firmness-wetness, and marbling, and percentage moisture and bound water of the longissimus muscle, and shear force were not affected ($P > .10$) by betaine. Betaine was not detectable ($< .07$ mg/g) in the longissimus muscle of pigs fed 0% betaine, but betaine was detectable and relatively constant in pigs fed .125, .250, or .500% betaine (.22, .17, and .21 mg/g respectively). Betaine improved carcass traits when provided at .250% of the diet and improved some aspects of pork quality.

Key Words: Pigs, Betaine, Pork Quality

160 Margins of safety can be lowered for supplemental copper, zinc, iron, and manganese in finishing pig diets. B. W. James*, S. S. Dritz, M. D. Tokach, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan.*

Growth performance and carcass characteristics were evaluated on 1,100 barrows (PIC C-22 x 337) to determine the effects of reducing supplemental Cu, Zn, Fe, and Mn concentrations during the finishing phase. Pigs (initially 46 kg) were sorted by weight in a randomized complete block design to one of four dietary treatments with 11 pens/treatment. Weights and feed intake were obtained biweekly. Pigs were marketed at an average of 115 kg BW. Measurements of carcass weight, fat depth, loin depth, lean percentage, and fat free lean index (FFLI) were obtained. Corn-soybean meal based diets were formulated in four phases (46 to 71 kg, 71 to 95 kg, 95 to 106 kg, and 106 to 115 kg) with 1.05, .83, .72, and .62% total lysine, respectively. Supplemental selenium and iodine were provided at .3 ppm for the first phase and .2 ppm for the

three remaining phases. All other nutrients met or exceeded the requirement estimates provided by NRC (1998). Vitamin levels were similar to current industry recommendations. Supplemental Cu, Zn, Fe, and Mn were provided in the control diet at 16.5, 165, 165, and 39.6 mg/kg (3 to 5 times NRC) during phase 1, and 11, 110, 110 and 26.4 mg/kg during phase 2, 3, and 4. Treatments 2 and 3 provided 50 and 25%, respectively, of the supplemental trace minerals included in the control diet while treatment 4 provided 50% during phase 1 and no supplemental trace minerals in the last three phases. Overall ADG (.76, .78, .78, and .77 kg/d), feed efficiency (.37, .38, .38, and .37), FFLI (49.1, 49.0, 49.1, and 49.1), or other growth and carcass criteria were not influenced ($P > .10$) by dietary treatment. These results suggest that margins of safety for Cu, Zn, Fe, and Mn can be lowered significantly in diets fed to terminal-cross finishing pigs without influencing growth performance or carcass traits.

Key Words: Trace minerals, Growth, Carcass characteristics

161 Biological role of pantothenic acid in the pig. T. S. Stahly and T.R. Lutz*, *Iowa State University, Ames.*

D-calcium pantothenate (0, 10.8, 21.6 ppm) was added to a basal diet to create three dietary concentrations of bioavailable pantothenic acid (PA; analyzed values corrected for bioavailability of 3.2, 13.6, 26.7 ppm). Pigs (10 sets of 3 littermates/strain) from moderate and high lean strains with respective BW gain contents of 17.2 and 17.6% protein and 11.5 and 9.8% fat were individually penned, and self-fed the basal diet (all vitamins except PA at 600% NRC, 1998) from weaning (12 d of age) to 10 kg BW. Pigs were then allotted within litter to one of three PA concentrations and fed their respective diets from BW ($\pm .3$ kg) of 10 to 27 kg to determine the biological role and utilization of PA in pigs. A fourth pig in each litter was killed at 10 kg BW for determination of initial body composition. Total body PA was initially $44 \pm .7$ mg in both strains and at 27 kg BW increased linearly (117, 160, 181 mg; $P < .01$) as dietary PA increased. Using regression analysis, endogenously synthesized PA was estimated as 2.85 mg/ BW kg^{.75}/d. The gross efficiency of retention of PA (diet and endogenous) was estimated as 10.5% and was independent of diet. As dietary PA increased, daily BW gain (679, 688, 684 g) and energy retention (1.37, 1.35, 1.35 Mcal) were not altered. But dietary PA additions improved feed/gain ratios (1.44, 1.43, 1.40; $P < .12$), increased protein content of BW gain (17.34, 17.46, 17.48%; $P < .01$) and decreased fat content of BW gain (11.15, 10.43, 10.36%; $P < .01$) resulting in a greater protein/fat ratio in BW gain (1.58, 1.71, 1.73; $P < .03$) with the magnitude of the responses being greater ($P < .05$) in the moderate lean strain. Daily PA intake, mg/BW kg^{.75}, was positively and negatively related to the amounts of dietary energy deposited as body protein and fat, respectively. Based on these data, PA in amounts above that needed to support body energy retention has a biological role in regulating body composition particularly in physiological states of high fat deposition.

Key Words: Pantothenic Acid, Body Composition, Pigs

162 Food-grade sorghum in diets for nursery pigs. D. W. Dean*, J. D. Hancock, R. H. Hines, L. J. McKinney, K. C. Behnke, and D. J. Lee, *Kansas State University, Manhattan.*

A total of 180 weanling pigs (6.1 kg average initial BW) were used to determine the effects of food-grade sorghum on growth performance. The pigs were blocked by weight and allotted to pens based on sex and ancestry. There were six pigs per pen and six pens per treatment. Treatments were mill-run corn, a bronze-pericarp sorghum hybrid (Pioneer 8500), and three food-grade (white seed/tan plant) sorghums (NC+ 7W97, Cargill 888Y, and Jowar 1) ground through a hammermill (1.6 mm screen) to a mean particle size of approximately 500 microns. Cargill 888Y and Jowar 1 were normal for starch type while NC+ 7W97 was heterowaxy. Corn- and sorghum-based diets were formulated using kg/kg substitutions. The sorghums required less net energy to grind with greater production rates ($P < .001$) than corn. The NC+ hybrid required less energy to grind ($P < .001$) with greater production rate ($P < .02$) than the other food-grade hybrids. For the pig experiment, there were no differences in rate or efficiency of gain among pigs fed corn versus the sorghums ($P > .7$), bronze versus food-grade sorghums ($P > .5$), and heterowaxy versus normal starch type sorghums ($P > .2$). However, gain/feed tended to be greater ($P < .1$) for Jowar 1 versus Cargill 888Y. In conclusion, our results suggest that hammermill production rate can

be increased with less energy required to grind when using sorghum versus corn. Furthermore, NC+ 7W97 ground more efficiently than did the other food-quality sorghums. However, feeding value was similar among corn and the various sorghum hybrids used in this experiment.

Item	Pioneer		Cargill		NC+	
	Corn	8500	888Y	Jowar 1	7W97	SE
Grinding energy, kWh/t	17.5	13.4	14.5	14.1	12.1	.2
Production rate, t/h	1.11	1.51	1.34	1.32	1.54	.05
ADG, g	479	475	493	478	472	10
ADFI, g	657	652	681	631	649	14
Gain/feed, g/kg	729	729	724	758	727	10

Key Words: Food-Grade Sorghum, Heterowaxy Sorghum, Pig

163 Effect of feeding organic and inorganic sources of zinc on nursery pig growth performance. C. L. Case* and M. S. Carlson, *University of Missouri, Columbia, MO.*

Two 28-d experiments were conducted to determine the effect of feeding pharmacological concentrations of zinc (Zn), from organic and inorganic trace mineral sources, on nursery pig growth performance. Blood was collected for plasma Zn analysis on d 14 in Exp. 1 and d 7 and 28 in Exp. 2. In Exp. 1, ninety crossbred pigs (24 ± 7 d of age; 6.45 kg avg. initial BW) were weaned and allotted to dietary treatment utilizing 6 replications of 3 pigs/pen. In Exp. 2, one hundred crossbred pigs (18 ± 2 d of age; 5.47 kg avg. initial BW) were weaned and allotted to dietary Zn treatment with 5 replications of 4 pigs/pen. In Exp. 1 and 2, a Phase I (d 1 - 14) nursery diet was fed as crumbles and Phase 2 (d 15 - 28) nursery diet was fed as pellets. Both dietary Phases contained the same 5 treatments; (1) 150 ppm Zn as ZnO, (2) 500 ppm Zn as ZnO, (3) 500 ppm Zn as Availa-Zn (amino acid complex), (4) 500 ppm Zn as SQM-Zn (polysaccharide complex), and (5) 3,000 ppm Zn as ZnO. During any wk in Exp. 1, and overall, pigs fed 500 ppm Zn as SQM-Zn or 3,000 ppm Zn as ZnO had greater ADG ($P = .006$) than pigs fed 150 or 500 ppm Zn as ZnO, or 500 ppm Zn as Availa-Zn (.44 and .46 kg/d vs. .35, .38, and .33 kg/d respectively). On d 14 of Exp. 1, pigs fed 3,000 ppm Zn as ZnO had the highest ($P = .0001$) plasma Zn concentrations. Pigs fed 500 ppm Zn as ZnO, 500 ppm Zn as SQM-Zn, or 500 ppm Zn as Availa-Zn had intermediate plasma Zn concentrations, with 500 ppm Zn as SQM-Zn having higher ($P = .04$) plasma Zn concentrations than pigs fed 150 ppm Zn as ZnO. In Exp. 2, pigs fed 3,000 ppm Zn as ZnO had greater ($P = .005$) ADG and ADFI than pigs fed any other dietary treatment. On d 7 of Exp. 2, there were no plasma Zn concentration differences observed, however, on d 28 pigs fed 3,000 ppm Zn as ZnO had higher plasma Zn concentrations than pigs on any other Zn treatment ($P = .0001$). In conclusion, feeding 3,000 ppm Zn as ZnO improved nursery pig performance, however, under certain nursery conditions, the use of 500 ppm Zn as SQM-Zn, an organic Zn polysaccharide complex, may also enhance performance.

Key Words: Pigs, Zinc, Growth

164 Impact of phytase and pharmacological concentrations of Zn on nursery pig performance and metallothionein in the liver and kidney. K. M. Hargrave*, M. M. Martinez, G. M. Hill, J. E. Link, C. W. Ernst, and N. E. Raney, *Michigan State University, East Lansing.*

Pharmacological (Phm) dietary zinc (Zn), from zinc oxide (ZnO), stimulates growth in nursery pigs and dietary phytase (Phy) supplementation increases the availability of bound cations, including Zn. Our objective was to determine if Phm Zn + Phy could improve performance, copper (Cu) and Zn status, and alter metallothionein (MT) concentration. In study 1, 12 barrows (21 d, 6.35 kg) were allotted by weight, age and litter to: **A** - adequate Zn (150 ppm), no Phy; **AP** - adequate Zn + Phy (500 FTU/kg Natuphos®); **P** - Phm Zn (2000 ppm from ZnO), no Phy; or **PP** - Phm Zn + Phy. Pigs were individually penned and fed a phase 1 diet for 14 d; blood samples were obtained, pigs were killed, and duodenal mucosal cells, liver and kidney were collected. Zn and Cu concentrations (conc) were determined in plasma, liver and kidney; MT conc was determined in mucosal cells, liver and kidney. In study 2, 96 mixed sex pigs (20 d, 6.54 kg), were allotted as in study 1 to the same diets plus: **H** - high Zn (1000 ppm from ZnO), no Phy; **HP** - high Zn + Phy. Pigs were fed a phase 1 diet for 14 d. Two pigs per pen (one/sex, n = 24) were killed and tissues were collected and analyzed as in study

1. The remaining pigs (n = 72) were fed a phase 2 diet (same dietary additions) for an additional 14 d. Feed disappearance and BW were recorded weekly. In study 1, Phm Zn (P and PP) increased hepatic Zn conc ($P < .05$) compared to the adequate diets (A and AP). Addition of Phy did not significantly alter hepatic Zn conc regardless of dietary Zn. Plasma Zn conc was increased ($P < .05$) by dietary Phy, but only when Phm Zn was fed (PP). Renal Zn conc and hepatic MT were increased ($P < .05$) in pigs fed PP compared to those fed A or AP. In study 2, the addition of Phy increased ADG ($P < .01$) in pigs fed Phm Zn and improved G:F in both high and Phm treatments (.40 vs .45, .43 vs .51 respectively; $P < .05$). Plasma, liver and kidney Zn and kidney MT ($P < .01$) were increased in PP compared to all other diets. Dietary Phy increased ($P < .01$) liver Zn and kidney Cu in high and Phm Zn diets, to the extent that conc in HP were the same as those in pigs fed P. These data suggest that addition of Phy improves Zn availability and thus may be fed with lower Zn conc to increase performance of nursery pigs.

Key Words: Nursery Pigs, Zinc, Metallothionein

165 Efficacy of added zinc oxide levels with or without an antibacterial agent in the postweaning diets of pigs. D. C. Mahan*, S. D. Carter, G. C. Cromwell, G. M. Hill, R. L. Harrold, A. J. Lewis, and T. L. Veum, *NCR-42 Swine Nutrition Committee.*

Usage of ZnO in the diets of weanling pigs has increased because of its efficacy in promoting postweaning performance. Because there has been an additive performance response from adding copper sulfate and dietary antibiotics during the postweaning period, the efficacy of ZnO and an antibacterial agent was investigated. A regional experiment conducted in seven states (KY, MI, MO, ND, NE, OK, OH) evaluated the efficacy of ZnO levels (0, 1,500, 3,000 ppm) with or without an antibacterial agent (carbadox) during a 4-wk postweaning period. The study was a 3 x 2 factorial arrangement in a RCB design conducted in 20 replicates involving 918 pigs. Common diet formulas were used at the different locations, but each used their own source of ingredients except for ZnO and carbadox. Diets were formulated to contain 1.50% lysine during the first week postweaning after which a 1.30% lysine diet was fed from 2 to 4 wk. Weaning age between station varied from 14 to 21 d, pen space ranged from .28 to .38 m² per pig, and pig numbers per pen varied from 5 to 20. Facilities and pen conditions within replicate were constant. Each station conducted a minimum of two replicates. Statistical analyses demonstrated a ($P < .01$) station response in pig performance but no interaction ($P > .15$) between stations and treatment. The main effects demonstrated no gain or feed intake response to carbadox during the initial week postweaning, but there was a trend for ZnO levels to increase growth ($P = .08$) and feed intake ($P = .11$). For the 2 to 4 wk period, both carbadox and ZnO each resulted in significant ($P < .01$) gain and feed intake responses, with the effects being additive. The response to ZnO plateaued at the 1,500 ppm Zn level. These results suggest that ZnO at 1,500 ppm and fed in combination with carbadox resulted in superior postweaning pig performance than when either were fed alone.

Key Words: Zinc, Antibacterial agent, Pigs

166 Effect of mannan oligosaccharide (Bio-Mos®) supplementation with and without zinc oxide on performance and immunocompetence of weanling pigs. M. E. Davis*¹, C. V. Maxwell¹, E. B. Kegley¹, B. Z. de Rodas¹, K. G. Friesen¹, D. H. Hellwig¹, D. C. Brown¹, and R. A. Dvorak², ¹University of Arkansas, Fayetteville, ²Alltech, Inc., Nicholasville, KY.

Two trials were conducted with 216 barrows (The Pork Group, Inc.; 21 ± 2 d of age; 5.2 kg BW) each from two locations to determine the efficacy of Bio-Mos® (BM) as an alternative to growth promoting levels of ZnO. Pigs were blocked by initial BW and penned in groups of 6 (9 and 6 pens/treatment in Exp. 1 and 2, respectively) in an off-site nursery. Treatments were arranged as a 2 x 2 (Exp. 1; 0, and .2% BM) or a 2 x 3 factorial (Exp. 2; 0, .2, and .3% BM) with 2 levels of ZnO (165 and 2465 ppm Zn). Experimental diets were fed throughout each study and contained 1.5% Lys during phase 1 (d 0 to 10), 1.35% Lys during phase 2 (d 10 to 24), and 1.2% Lys during phase 3 (d 24 to 38). Two pigs/pen were bled via venipuncture and a lymphocyte blastogenesis assay was performed. In Exp. 1, ZnO addition increased ($P \leq .05$) ADG during phase 1, ADFI during phase 1 and 2, and G:F in the overall study (d

0 to 38). In phase 2 and overall, ADG increased when BM was added to diets containing 165 ppm Zn, but decreased when BM was added to diets with 2465 ppm Zn (interaction, $P \leq .08$). In Exp. 2, ZnO inclusion increased ($P \leq .05$) ADG, ADFI, and G/F during phase 1 and overall. Average daily gain and G/F increased when BM was added during phase 1 and G/F increased in the overall trial (quadratic, $P \leq .05$). During phase 2, ADG decreased when BM was added at .2% in diets containing 165 ppm Zn, then increased with the addition of .3% BM; however, BM addition at .2% and .3% in diets containing 2465 ppm Zn improved ADG (interaction, $P \leq .05$). Lymphocyte proliferation in response to pokeweed mitogen increased in pigs fed diets containing 2465 ppm Zn with .2% BM when compared to to pigs fed 0 or .3% BM, but was similar for all BM levels in diets with 165 ppm Zn (interaction, $P \leq .13$). Response to BM compared to ZnO seems to be dependent on level of BM and ZnO in the diet, and may be impacted by weaning conditions.

Key Words: Swine, Oligosaccharide, Zinc

167 Bioplex iron as a hematinic for nursery pigs. B.G. Harmon*, S.L. Barlow, and M.E. Einstein, *Purdue University*.

Forty seven litters were randomly assigned to treatments of 90 ppm of supplement iron provided either as organic iron complex (600 ppm Bioplex Iron[®]) or ferrous sulfate (450 ppm ferrous sulfate), which were provided in corn/soybean meal based diets the last 30 days of gestation (2.2 kg/day) and throughout 19 days of lactation (ad libitum fed). Half of the pigs in each litter were injected with 100 mg iron as iron dextran (Durvet[®]) when the pigs were processed at about 24 hours of age. The remaining pigs received no supplemental iron. Blood hemoglobin and hematocrit were measured in the pigs initially and at 19 days of age. Sow milk iron was measured at 15 days of lactation. Liver iron was measured in 2 pigs in each litter when pigs were 19 days of age. The source of iron in the sow diet had no significant effect on blood parameters in the pigs at birth or at 19 days of age. (Hemoglobin values at 19 days of age were 10.0 g/100 ml for dietary iron sulfate with iron injection, 6.4 g/100 ml without iron injection; 11.0 g/100 ml for dietary Bioplex Fe[®] with iron injection, 5.9 g/100ml without iron injection). Iron content in pig livers and iron content in sows' milk was not significantly affected by sow diet. Pigs weaned per litter (8.16 for sows receiving ferrous sulfate and 8.95 for sows receiving Bioplex Iron[®]) were not significantly different for treatment but the number of stillborns and mortalities prior to pig treatment and during lactation was less for litters nursing sows receiving Bioplex Fe[®] (2.45 pigs on iron sulfate and 1.39 pigs on Bioplex Fe[®]). Pigs receiving iron dextran had significantly greater ($P < .01$) hemoglobin, hematocrit, liver iron and weight gain than did pigs without injections. The noninjected pigs demonstrated mild anemia with marginal hemoglobin and hematocrit values. Fecal iron from either dietary iron source or residual iron from steel farrowing crates may have diminished the severity of anemia. Bioplex Iron[®] may influence livability of pigs at birth, but did not provide an effective hematinic for nursing pigs when fed to sows in late gestation and during lactation at 90 ppm of iron.

Key Words: Hematinic, Young pig

168 Effect of dietary phosphorus regimen on body P and N accretion-excretion in pigs. T.S. Stahly*, D.R. Cook, T.R. Lutz, and R.C. Ewan, *Iowa State University, Ames, IA*.

Pigs were self-fed a basal diet (corn, soy, whey) containing .56, .66, .80, .90, 1.00, or 1.11% analyzed phosphorus (P) with estimated bioavailable P (NRC, 1988) concentrations of .2, .3, .4, .5, .6, or .7%, respectively, from 6 to 32 kg BW. Apparent body P and nitrogen (N) accretion and excretion were determined in each pig for 4 d at BW (± 1.1 kg) of 10 and 30 kg. Dietary P concentrations were achieved by the substitution of mono-dicalcium phosphate for starch-limestone in the basal diet (.56%P; 4.61% N) with Ca maintained at 1.15%. Pigs (8 sets of 6 littermate barrows) were allotted within litter to one of six P regimens. As dietary P concentrations and daily P intakes (6.1, 7.2, 8.7, 10.9, 11.4, 12.2 g) increased (pooled across BW), daily accretion of body P (3.4, 4.3, 5.4, 5.9, 5.8, 5.8 g) and body N increased ($P < .05$) quadratically as did P accretion as a proportion of BW gain (.57, .71, .83, .85, .84, .90%). As dietary P increased, daily P excretion (2.7, 2.9, 3.3, 4.9, 5.7, 6.4 g) and the proportion of P intake excreted in urine (2.8, 3.0, 4.0, 8.0, 13.4, 18.2%) increased ($P < .01$) quadratically and the ratio of P excretion to N excretion increased ($P < .01$) linearly (.112, .120, .146, .169,

.199, .245). However, as dietary P concentration increased up to that which supported maximum P accretion, body N accretion was improved and excretion of P and N expressed as a % of daily P and N intake or as g/kg daily body N accretion were not altered or were minimized.

Key Words: Phosphorus, Nitrogen, Pigs

169 Effect of bile salt supplementation in fat digestion in early weaned pigs. B.G. Harmon*¹, G.M. Hill², and D.C. Mahan³, ¹*Purdue University*, ²*Michigan State University*, ³*Ohio State University*.

Four hundred and eighty segregated early weaned pigs, 14-18 days of age, were used in a study conducted jointly at Michigan State University, Ohio State University and Purdue University to study the effect of porcine bile salts on post-weaning performance in starter diets. Porcine bile salts were added at 0.00, 0.15, 0.30 and 0.45% into each phase of a three phase complex starter diet program. Phase 1, 2 and 3 diets were fed for 10, 14 and 14 days respectively. All diets contained 7% added fat as yellow swine grease. Porcine plasma protein was fed at 7% in Phase 1. Dried whey was fed at 15% in Phase 1 and 2 and at 12% in Phase 3. Two or three percent of fish meal and of blood meal were fed in each phase. Diets to be used at all three stations were mixed and pelleted at one site, split three ways and delivered to the research facilities. Six or seven replications were conducted at each of the three locations. Pigs were weighed at 10, 24 and 38 days on test. Daily gain, feed intake and gain:feed at the end of 10 days were 251, 239, 223, 238 g/d; 259, 262, 248, 249 g/d; and .969, .914, .900, .956 g/g, respectively for the titrated levels of bile salts. At the conclusion of the trial at 38 days, the overall daily gain, feed intake and gain:feed were 457, 449, 438, 443 g/d; 593, 597, 591, 597 g/d; and .770, .753, .742, .743 g/g, respectively with no significant difference ($P > .05$) in performance due to dietary treatment. The results indicate that bile salts do not improve performance of early-weaned pigs receiving diets containing 7% added yellow pork grease for any period during the three phase diet 38 day study.

Key Words: Bile salts, Young pig, Fat digestion

170 The tryptophan requirement of Phase I nursery pigs. A. C. Guzik*¹, B. J. Kerr², T. D. Bidner¹, and L. L. Southern, ¹*LSU Agricultural Center, Baton Rouge, LA*, ²*Nutri Quest, Chesterfield, MO*.

Three experiments were conducted to determine the digestible tryptophan (Trp) requirement of Phase I nursery pigs. In each experiment, treatments were replicated with four to seven pens of four to six pigs each in a randomized complete block design. Pens contained an approximately equal number of barrows and gilts. The average ages of the pigs were 17 (Exp. 1) and 19 d (Exp. 2 and 3). Response variables were ADG, ADFI, gain:feed, and plasma urea N concentrations. Experimental diets (1.4% digestible lysine) were pelleted and fed for 15 (Exp.1), 8 (Exp. 2), or 16 d (Exp. 3). An initial experiment was conducted to verify that a Trp deficient diet, when supplemented with sufficient L-Trp, produced growth performance similar to pigs fed a conventional corn-soybean meal diet. In Exp. 1, 84 crossbred pigs (average initial BW of 4.9 kg) were fed one of three experimental diets: 1) Trp deficient (.13% digestible Trp) basal diet composed of corn, fish meal, corn gluten meal, gelatin, whey, and oatmeal; 2) basal + .113% L-Trp (.243% digestible Trp); or 3) conventional corn-soybean meal diet (.253% digestible Trp) composed of whey, fish meal, and oatmeal. Overall ADG, ADFI, and gain:feed were decreased ($P < .01$) in pigs fed the Trp-deficient diet relative to pigs fed the diets adequate in Trp. Also, there was no difference ($P > .10$) in growth performance of pigs fed the corn-soybean meal diet and those fed the basal diet supplemented with L-Trp. In the subsequent two experiments, 120 (Exp. 2) and 180 (Exp. 3) crossbred pigs with initial average BW of 5.7 (Exp. 2) and 5.1 kg (Exp. 3) were fed the basal diet used in Exp. 1 supplemented with 0, .03, .06, .09, .12, and .15% L-Trp, resulting in six treatments with .13, .16, .19, .22, .25, and .28% digestible Trp. Data for ADG and gain:feed were analyzed using the broken-line model to estimate the Trp requirement. The digestible Trp requirement was estimated to be .19% (.23% total Trp) in Phase I nursery pigs.

Key Words: Pig, Tryptophan, Requirement

171 Efficacy of a modified high protein Peptide PlusTM in phase 1 diets for conventionally reared nursery pigs. C.V. Maxwell^{*1}, B.Z. de Rodas¹, M.E. Davis¹, Z.B. Johnson¹, D.C. Brown¹, D.L. Kirkpatrick¹, and C.R. Hamilton², ¹University of Arkansas, Fayetteville, ²Esteem Products, Inc, Irving, TX.

A total of 288 pigs (18 ± .2 d of age) were used in two experiments to evaluate the feeding value of Peptide PlusTM 78 (PP78), a modified Peptide PlusTM (PP) relative to spray-dried plasma protein (SDPP) in phase 1 diets (d 0 to 14 postweaning). Peptide PlusTM is a source of peptides and amino acids made from 100% beef muscle. Pigs were housed in a conventional nursery and allowed to consume diets ad libitum. In each experiment 144 pigs (5.2 kg BW) were penned in groups of three (8 pens/TRT). Treatments (TRT) were: 1) a negative control (NC) phase 1 diet containing 17% soybean meal (SBM) and devoid of SDPP, PP78 or PP, 2) a phase 1 diet containing 4.0% SDPP and 7% SBM, 3, 4, 5) as 2 with PP78 replacing 33, 66, or 100% of the SDPP Lys, respectively, and 6) as 2 with conventional PP replacing 100% of the SDPP Lys. Substitutions in all diets were made on an equal Lys basis at the expense of corn. The diets were equalized in total Lys (1.50%), and lactose (14.7%) content. In Exp. 2 all pigs were fed a common phase 2 diet (1.35% Lys; d 14 to 28 postweaning). In the phase 1 combined analysis, wk 1 ADG for TRT 1 to 6 was 195, 228, 239, 208, 234 and 190 g, respectively (NC vs TRT 2, P < .02; cubic effect of increasing PP78, P < .02; TRT 2 vs TRT 6, P < .01). Gain/feed for TRT 1 to 6 was .90, 1.00, .95, .91, .99 and .91, respectively (NC vs TRT 2, P < .05). During d 0 to 14 postweaning, ADG for TRT 1 to 6 was 271, 302, 319, 291, 303, and 268 g, respectively (NC vs TRT 2, P < .02; cubic effect of increasing PP78, P < .05; TRT 2 vs TRT 6, P < .01). Gain/feed for TRT 1 to 6 was .84, .88, .87, .85, .89 and .82, respectively (TRT 5 vs TRT 6, P < .02). In phase 2 (Exp. 2), pigs previously fed PP78 continued to have improved ADG (quadratic effect of increasing PP78, P < .04). Replacing SDPP in phase 1 nursery diets with PP78 results in improved performance at lower inclusion levels and similar performance at the 100% substitution level.

Key Words: Pigs, Protein Source, Performance

172 Effects of spray-dried animal plasma source on weanling pig performance. M. U. Steidinger^{*}, R. D. Goodband, M. D. Tokach, J. L. Nelssen, S. S. Dritz, and R. E. Musser, *Kansas State University*.

Five hundred sixty weanling pigs were used in three studies to evaluate the effects of different spray-dried animal plasma (SDAP) sources on pig growth performance. Pigs were fed either a control diet (no SDAP) or one of four diets containing different plasma sources added at 5.0 % of the total diet and replacing soybean meal on an equal lysine basis. In each experiment, a different lot of each of the four plasma sources was utilized. The 28 d growth assays were divided into two phases with the experimental diets (1.4 % lysine) fed from d 0 to 14 and all pigs fed a common diet (1.35 % lysine) from d 14 to 28. In all experiments, pigs (PIC) were blocked by initial BW, equalized for sex, and allotted to one of the five dietary treatments. In Exp. 1, from d 0 to 7, ADG was 16, 79, 91, 126, and 117 g/d for pigs fed the control and plasma sources 1, 2, 3 and 4, respectively. Pigs fed SDAP source 3 had increased ADG compared to pigs fed SDAP source 1 with pigs fed SDAP sources 2 and 4 having intermediate performance. In Exp. 2, from d 0 to 7, ADG was 100, 193, 189, 165, and 188 g/d for pigs fed the control and plasma source 1 through 4, respectively. Pigs fed SDAP had improved (P < .01) ADG and G/F compared to pigs fed the control diet. Pig growth performance was not affected by the source of spray-dried animal plasma used in the diet (P > .10). In Exp. 3, from d 0 to 7, ADG was 39, 108, 78, 66, and 108 g/d for pigs fed the control and plasma source 1 through 4, respectively. Pigs fed SDAP sources 1 and 4 had improved (P < .03) ADG, ADFI and G/F compared to the control pigs with pigs fed SDAP sources 2 and 3 having intermediate performance. In Exps. 1, 2 and 3, growth performance, d 14 to 28 and d 0 to 28, was not affected by the diet fed from d 0 to 14. Results of these studies suggest that there are greater differences between lots or batches of SDAP from the same source than between sources. None of the SDAP sources tested consistently provided the best growth performance.

Key Words: Spray-dried animal plasma, Weanling pig, Growth performance

173 Feeding spray-dried plasma (SDP) alters the immunological response of the weaned pig to a lipopolysaccharide (LPS) challenge. K.J. Touchette^{*1}, J.A. Carroll², G.L. Allee¹, R.L. Matteri², C.J. Dyer², L.A. Beausang³, and M.E. Zannelli³, ¹University of Missouri-Columbia, ²Animal Physiology Research Unit, Agricultural Research Service, USDA, Columbia, MO, ³Endogen, Inc., Woburn, MA.

Previously we reported that pigs fed SDP have a greater HPA axis response (i.e., higher serum ACTH and cortisol) following an LPS challenge than non-SDP fed pigs. The objective of this study was to evaluate the effect of SDP and an LPS challenge on immune function. Twenty pigs (14d, 5 kg) were weaned to an isolated environment and allotted to 1 of 4 treatments in a 2x2 factorial arrangement, with two levels of SDP (0 vs 7%) and 2 i.p. injections (LPS vs saline). Diets, formulated to contain equal ME and digestible essential amino acids, were fed for 7d postweaning. On d7, i.p. injections of either LPS (150 µg/kg BW) or saline were given, followed by blood sample collection at 15-min intervals for 3hr. After 3hr, pigs were sacrificed and tissue was collected for mRNA analysis of IL-1β and IL-6. The serum TNF-α response to the LPS challenge was greater for pigs fed the SDP diet (peak was 15.7 ng/ml at 1.25hr post-challenge) compared to pigs fed the non-SDP diet (peak was 6.3 ng/ml at 1.5hr post-challenge). The serum IFN-γ response 3hr post-LPS was greater in pigs fed the SDP diet (1.75 ng/ml) than pigs fed the non-SDP diet (.24 ng/ml). There were diet by LPS interactions for IL-1β in the adrenal (P<.06), spleen (P<.002) and thymus (P<.023) such that LPS decreased IL-1β expression only in pigs fed the non-SDP diet. SDP fed pigs had lower levels of IL-6 mRNA in the adrenal gland, spleen, and the pituitary (P<.05), but not the hypothalamus or thymus gland. These results are consistent with studies that demonstrate that immunologically naïve mice respond much greater to an LPS challenge than immunologically primed mice. This suggests that feeding SDP may provide immunological protection for weaned pigs under typical production conditions.

Key Words: Plasma Protein, Immune Function, Pigs

174 Effects of water-soluble globulin on the growth performance of weanling pigs fed different diet complexities. M. U. Steidinger^{*1}, R. D. Goodband¹, M. D. Tokach¹, J. L. Nelssen¹, S. S. Dritz¹, B. Borg², and J. Campbell², ¹Kansas State University, Manhattan, ²American Protein Corp., Ames IA.

Weanling pigs (n=360; initially 5.0 kg and 17 d of age; PIC) were used to evaluate the effect of water-soluble globulin (WSG) on growth performance of pigs fed different diet complexities. Pigs were blocked by initial weight and allotted to one of six treatments. Treatments were based on three diet complexity regimens with or without supplemental WSG provided from d 0 to 14 after weaning. The 35-d growth assay was divided into three phases (d 0 to 7, 0 to 14, and 14 to 35) with corresponding dietary lysine levels of 1.6, 1.5 and 1.35%. Soybean meal replaced specialty protein sources and whey products to obtain the three different diet complexities during each phase. From d 0 to 7, pigs were offered WSG in a 3.0% solution through the water source with concentrations reduced to 1.5% from d 7 to 14. There were diet complexity × WSG interactions for ADG (P<.05) and G/F (P<.01) from d 0 to 7. Increasing diet complexity linearly improved ADG for pigs consuming water (41, 91, 122 g/d), whereas the response was quadratic for pigs consuming WSG (86, 127, 122 g/d). Similarly, pigs consuming water had improved G/F as diet complexity increased (.40, .79, 1.02), while diet complexity had little effect on G/F for pigs offered WSG (.95, 1.09, 1.10; adjusted for DM in WSG). From d 0 to 14, pigs fed the simple diet had lower ADG and G/F (P<.01) than pigs fed more complex diets. Pigs offered WSG had decreased (P<.01) ADFI and improved (P<.001) G/F from d 0 to 14. From d 0 to 35, increasing diet complexity improved ADG and ADFI (P<.03) while WSG, offered from d 0 to 14, had no effect on overall performance. These results show increasing diet complexity improves weanling pig growth performance through d 35 postweaning. Supplementing pigs with WSG improves ADG from d 0 to 7 and G/F from d 0 to 14 after weaning. These results also demonstrate that providing WSG allows use of a less complex diet to start pigs on feed the first week after weaning.

Key Words: Weanling pigs, Globulin protein, Diet complexity

175 Effects of pH level in spray-dried blood meal on growth performance in nursery pigs. J. M. DeRouchey*, J. L. Nelsens, M. D. Tokach, R. D. Goodband, J. C. Woodworth, and D. E. Real, *Kansas State University, Manhattan*.

Two hundred forty pigs (BW of 5.1 kg and 17 ± 2 d of age) were used in a 31-d growth assay to determine the effects of blood meal varying in pH after spray-drying on growth performance in phase II nursery pigs (BW of 7.0 kg). Decreased blood meal pH has been associated with decomposition of the blood meal from processing or prolonged storage. As pH decreases, offensive odors increase and may have a negative effect on palatability. All pigs were fed the same pelleted diets for 10-d post-weaning. Then, pigs were switched to experimental diets which included a control diet (10% spray-dried whey) with no added blood meal or four diets containing 2.5% spray-dried blood meal. The four blood meals were from the same processing facility, but had an initial pH of 7.4, 6.7, 6.4, and 5.9, respectively. Treatment diets were fed in meal form and formulated to contain 1.35% lysine, .82 Ca, and .48 available P. When pigs were fed the common diets from d 0 to 10 after weaning, ADG, ADFI, and G/F were 186 g, 195 g, and .95. For d 0 to 21 of the experiment (d 10 to 31 postweaning), ADG (449 vs 430 g) and ADFI (663 vs 627 g) were increased ($P < .02$) by adding blood meal to the diet compared with control pigs. Feed efficiency was not affected by blood meal addition. The pH of the blood meal did not influence performance with pigs fed all blood meal treatments having similar ADG (450, 446, 450, and 453 g) and gain/feed (.69, .66, .67, and .68, respectively). These results suggest that spray-dried blood meal addition at 2.5% is beneficial in phase II nursery diets, while blood meal pH does not appear to influence nursery pig performance.

Key Words: Pig, Blood Meal, Growth

176 Efficacy of different sources of zinc oxide for young pigs: growth and gut morphology. I. Mavromichalis*, C. M. Peter, T. M. Parr, D. Ganessunker, and D. H. Baker, *University of Illinois at Urbana-Champaign*.

Research in our laboratory indicated that commercial sources of ZnO differ widely in relative bioavailability (RBV) of Zn, but it is not known whether growth-promoting efficacy in young pigs is better with ZnO sources that are high or low in RBV. We compared a common ZnO (74% Zn) with a low RBV (37%) to a feed-grade ZnO (78% Zn) with a high RBV (95%). The low-RBV ZnO (W) manufactured by the Waelz process was greenish-brown whereas the high-RBV ZnO (HS) manufactured by the hydrosulfide method was pale yellow. In Exp. 1, 27 pigs with an average initial weight of 6.5 kg (28 d-of-age) were randomly assigned (3 replicates/treatment and 4 pigs/pen) to receive 0, 1,500, or 3,000 mg Zn/kg from HS in a 21-d growth assay. Growth rates responded linearly ($P < .05$) to incremental doses of Zn. In Exp. 2, 60 pigs with an average initial weight of 6.2 kg (28 d-of-age) were randomly assigned (5 replicates/treatment and 4 pigs/pen) to receive either 0 or 1,500 mg Zn/kg from either W or HS in an 11-d growth assay. Growth rate during the first 6 d was improved ($P < .05$) by the addition of ZnO, and there was a trend ($P < .10$) for greater weight gain in pigs receiving HS than W. During the entire 11 d, however, there was no difference in growth between the two sources of ZnO. In Exp. 3, 60 pigs with an average initial weight of 6.1 kg (28 d-of-age) were randomly assigned (5 replicates/treatment and 4 pigs/pen) to treatments in a 3-wk growth assay. Pigs received the same dietary treatments as in Exp. 2, with the exception that diets did not include any antimicrobial compounds. Growth performance was improved ($P < .05$) by the addition of either source of ZnO. During wk 1, however, pigs receiving HS grew faster ($P < .05$) than those receiving W, but the response difference diminished to a trend during the entire 21-d assay period. Morphology of duodenal, jejunal, and ileal gut sections was examined at d 21 of the assay, but neither source of ZnO had an effect on crypt depth, villus height or villus width.

Key Words: Nursery Pigs, Zinc Oxide, Relative Bioavailability

177 Influence of dietary methionine to methionine plus cysteine ratios on nitrogen retention in growing pigs. A. T. H. Reijmers*, A. M. Gillis, and C. F. M. de Lange, *University of Guelph, Guelph, Ontario, Canada*.

Estimates of the minimum methionine (MET) to methionine plus cysteine (M+C) ratio in diets for growing pigs range between 30 and 70% and may be affected by the dietary amino acid source, body weight, performance level and total M+C intake. The objective of the current study was to establish the minimum dietary available MET to M+C ratio for growing pigs using the nitrogen balance (N-balance) method. Ten gilts between 40 and 80 kg live body weight were fed diets based on corn starch, casein and synthetic amino acids, supplying equal moles of M+C, approximately 0.034 moles/d and supporting a protein deposition (PD) of 80% of the gilts' maximum PD's. The diets were confirmed to be first limiting in M+C. On a weight basis, the target ratios of MET to M+C were 42, 47, 52, 57 and 67% for five dietary treatments. Gilts were fed the experimental diets according to a repeated Latin Square design. Pigs were adjusted to dietary treatments for 5 days prior to a 5 day N-balance period. For the five respective treatments, PD's were 108, 116, 118, 120 and 121 g/d (SEM=1.35). Total nitrogen excretion (urine plus feces) was reduced ($P < .05$) and PD was increased ($P < .05$) when the MET to M+C ratio was increased to 52%. These values did not change ($P > .10$) when the MET to M+C ratio was further increased. Based on broken line-linear plateau regression analysis, a plateau in total nitrogen excretion and PD was achieved when the available MET to M+C ratio was 53.5% on a weight basis, or 49% on a molar basis. When a curvilinear model was used for data analysis, nitrogen excretion was minimized and PD maximized when the available MET to M+C ratio exceeded 57% on a weight basis or 52% on a molar basis.

Key Words: Pigs, Methionine, Cysteine

178 Effects of dietary betaine and methionine on growth performance, carcass characteristics, and plasma metabolites of finishing barrows. S.J. Kitt*, P.S. Miller, A.J. Lewis, and R.L. Fischer, *University of Nebraska, Lincoln*.

The objective of this experiment was to determine whether dietary betaine can partially replace methionine in diets for finishing barrows. Sixty-four barrows (initial BW = 46 kg) were blocked by weight, individually penned, and randomly allotted to receive one of eight dietary treatments. Treatments were two concentrations of betaine (0 or .125%) and four concentrations of methionine (from approximately 82 to 130% of the requirement, formulated on a true ileal digestible basis) in a 2×4 factorial arrangement. Amino acid requirements were predicted using the NRC model and estimated average daily lean growth from pigs with a similar genetic background. Diets were formulated to exceed all nutrient requirements except methionine. There were three phases: 46 to 59 (Phase 1), 59 to 86 (Phase 2), 86 to 112 (Phase 3) kg of BW. Supplemental choline (77 mg/kg of diet) and choline from organic ingredients supplied 587, 556, and 518 mg/kg total choline in Phases 1, 2, and 3, respectively. Blood samples were collected on the final day of each phase and analyzed for plasma urea and methionine concentration. Pigs were slaughtered when final BW was approximately 112 kg. Overall ADG, ADFI, ADG/ADFI, longissimus muscle area, and backfat depth were not affected ($P > .15$) by dietary betaine or methionine concentration. Fat-free lean gain tended ($P < .10$) to be increased by betaine, regardless of dietary methionine concentration. In each phase, plasma methionine concentration increased linearly ($P < .05$) as dietary methionine concentration increased. Plasma urea concentration was decreased ($P < .06$) in pigs fed betaine during Phase 3. The data suggest that methionine intake was not sufficiently deficient to assess the efficacy of betaine as a replacement for methionine in diets for finishing barrows. These data also suggest that current estimates of the methionine requirement of pigs with a similar lean growth potential may be too high.

Key Words: Betaine, Methionine, Pigs

179 Growth performance of gilts fed a standard corn-soybean meal diet or low-crude protein diets supplemented with crystalline amino acids. J. L. Figueroa*, A. J. Lewis, P. S. Miller, and R. L. Fischer, *University of Nebraska, Lincoln*.

The purpose of our research was to determine how far the crude protein concentration of a corn-soybean meal diet (with lysine, tryptophan, threonine, and methionine supplementation) can be reduced without reducing pig performance. Thirty-six gilts (initial weight 19.5 kg) were individually penned and fed one of six different diets in a randomized block design for 35 d. A control, 16% CP diet was compared with five low CP, amino acid-supplemented diets. The low CP diets contained 15, 14, 13, 12, and 11% CP and were supplemented with lysine, tryptophan, threonine, and methionine to provide the same concentrations, on a total basis, as those in the control diet. Gilts were allowed ad libitum access to feed and water. There were quadratic effects ($P < .01$) on ADG, ADFI, and ADG/ADFI as CP decreased in diets, with values for the 11% CP group being lower than for the other five dietary groups. Longissimus muscle area decreased linearly ($P < .01$) as CP decreased, but there was no CP effect ($P > .05$) on backfat thickness. Average daily lean gain decreased quadratically ($P < .001$) as dietary CP decreased and was much lower for the 11% CP diet than for all other diets. Plasma urea concentration decreased linearly ($P < .01$) as CP concentration decreased. Plasma concentrations of arginine, histidine, isoleucine, leucine, phenylalanine, and valine decreased as CP decreased ($P < .05$), whereas plasma lysine, threonine, and methionine increased ($P < .05$). Plasma tryptophan concentration was not affected. Thus, only when the CP concentration was reduced to 11% did gilts fail to achieve the same growth performance as gilts fed the 16% CP, control diet. These data suggest that other amino acids (e.g., isoleucine, valine, histidine) may reduce the growth performance when the crude protein concentration is reduced by more than four percentage units.

Key Words: Pigs, Amino Acids, Crude Protein

180 Lack of interaction between lysine levels fed in the grower and finisher diets. J. C. Woodworth*, S. S. Dritz, M. D. Tokach, R. D. Goodband, and J. L. Nelssen, *Kansas State University, Manhattan*.

A total of 1,200 pigs (initially 28 kg) were used to test the interactive effects of diet phase and lysine level on growth performance and carcass characteristics of finishing pigs. Experimental treatments were arranged as a split-plot design with gender (barrows vs. gilts) as the whole plot and dietary treatment as the sub-plots. Dietary treatments were arranged as a 2x2 factorial with main effects of lysine level (adequate vs. low) and phase (grower-28 to 77 kg vs. finisher-77 to 120 kg). All diets were corn-soybean meal based and were fed in meal form in four weight ranges (28 to 52, 52 to 77, 77 to 98, and 98 to 120 kg) and contained 6% choice white grease in the grower phase. Lysine:calorie ratio (g tot lys/Mcal ME) for the barrow adequate and gilt adequate diets were 3.24, 2.56, 1.95, and 1.80; and 3.50, 2.92, 2.75, and 2.10, respectively for the four weight ranges. Lysine:calorie ratio for barrow low and gilt low lysine diets were 2.76, 2.23, 1.50, and 1.27; and 3.01, 2.48, 1.80, and 1.50, respectively for the four weight ranges. As expected, gilts grew slower, had better G/F and leaner carcasses compared to barrows ($P < .05$). There were no interactions observed between lysine level and growth phase for the entire trial. Pigs fed the low lysine treatment had lower ($P < .05$) ADG and G/F compared to pigs fed the adequate lysine treatment in the grower (854 g and .51 vs. 876 g and .53, respectively) and finisher (636 g and .27 vs. 735 g and .32, respectively) phases. Carcass characteristics were not influenced ($P > .10$) by lysine level fed in the grower phase. However, pigs fed the low lysine treatment in the finisher phase had lighter, fatter, and less muscled carcasses; ($P < .05$). Carcass characteristics were influenced greater by lysine level fed in the finisher phase compared to that fed in the grower phase. These data suggest that feeding a deficient lysine level decreased ADG and G/F during both phases; however, no carryover effects were observed.

Key Words: Pigs, Lysine, Phase feeding

181 The effects of compensatory growth and form of amino acid supply on plasma urea concentration, organ weights, and carcass characteristics in gilts. R.L. Fischer*, P.S. Miller, and A.J. Lewis, *University of Nebraska, Lincoln*.

Forty-six, medium-lean growth gilts (35.1 kg BW) were used to examine the effects of compensatory growth and amino acid supply on plasma urea concentrations, organ weights, and carcass characteristics. The two dietary treatments used in the experiment were a corn-soybean meal diet and a corn-soybean meal diet supplemented with crystalline lysine. Four gilts were slaughtered at the beginning of the trial to determine initial carcass composition. Eighteen gilts were randomly allotted to a 21-d ad libitum (AL) eating period and 24 gilts were assigned to a 42-d restricted-realimentated (RR) treatment. The RR regimen consisted of a 21-d restriction period followed by a 21-d ad libitum eating period (realimentation). At the end of the restriction period, six gilts were slaughtered to determine initial carcass measurements for the RR group. Three gilts from each diet treatment were slaughtered in six consecutive weeks during the ad libitum eating periods. During wk 1 of the ad libitum eating period, ADG and ADG/ADFI were greater ($P < .05$) and ADFI was lower ($P < .05$) in the RR gilts compared to the AL gilts. During wk 2 of the ad libitum eating period, ADG and ADFI were greater ($P < .05$) in the RR than the AL gilts. Ultrasound scanning measurements showed an increase ($P < .05$) in longissimus muscle area and a decrease ($P < .05$) in backfat depth during the first 2 wk of the ad libitum eating period in the RR group compared to the AL group. Plasma urea concentrations were lower ($P < .05$) in gilts fed the lysine-supplemented diet than in gilts fed the corn-soybean meal diet. Livers of the RR gilts were heavier ($P < .05$) than those of AL gilts during wk 1 and 2 of the ad libitum eating period. These results show that the gilts in the RR group exhibited compensatory growth during the first 2 wk of the ad libitum eating period. Also, during the restriction period pigs deposited less backfat and maintained longissimus muscle deposition.

Key Words: Pigs, Compensatory Growth, Carcass Composition

182 Effect of reduced dietary crude protein on nitrogen retention and ammonia production in growing pigs. E. R. Otto*, M. Yokoyama, S. Hengemuehle, and N. L. Trottier, *Michigan State University, East Lansing, MI*.

Six crossbred barrows (44.67 ± .76 kg), arranged in a 6 x 6 Latin square were used to investigate the effect of six dietary crude protein (CP) + crystalline amino acid (CAA) treatment combinations on nitrogen (N) balance and ammonia (NH₃) emission. Dietary treatments (TRT) were: 15% ICP corn-soybean meal (CSBM) (1), 12% CP+CAA (2), 9% CP+CAA (3), 6% CP+CAA (4), 15% CP casein (5) and protein-free (6). The ratio of essential and non-essential amino acid N was maintained at 45:55 by addition of L-glutamate. Following adaptation (5d) to diets, feces and urine were collected over a 5-d period. Total feces and total urine within pig and period were pooled. Pooled samples of feces and urine were sub-sampled and mixed 1:5 ratio (fecal wt/urine vol) into slurries. The slurry samples were fermented for 31d at room temperature (21°C). Fermented slurries were sub-sampled and headspace air measured for NH₃ at 24, 48 and 72h. Nitrogen retention was not different ($P > .05$) for TRT 2,3 and 4 when compared to TRT 1. Nitrogen utilization (NU) increased as levels of CP decreased ($P < .05$). Nitrogen digestibility (ND) for TRT 4 and 5 was higher ($P < .05$) compared to TRT 1, but TRT 2 and TRT 3 were similar to TRT 1 ($P > .05$). Nitrogen digestibility for TRT 4 and 5 were different from each other ($P < .05$). Ammonia decreased as CP levels decreased. Ammonia production from TRT 2,3,4, and 6 were different from TRT 1 ($P < .001$). Therefore, NU can be maintained and NH₃ production can be decreased with lower CP levels (down to 6%) with CAA and L-glutamate supplementation.

Item	15% CP	12% CP +CAA	9% CP +CAA	6% CP +CAA	Casein	SEM
N In, g/d	42.47 ^{ab}	39.36 ^{bc}	33.37 ^c	26.33 ^d	48.81 ^a	1.56
N Out, g/d	18.76 ^a	14.78 ^b	11.90 ^b	6.89 ^c	14.62 ^b	0.82
N Ret., g/d	23.71 ^b	24.57 ^b	21.46 ^b	19.44 ^b	34.19 ^a	1.42
N Dig.	80.28 ^c	81.09 ^{bc}	80.13 ^c	85.54 ^b	95.81 ^a	1.03
N Util.	55.90 ^d	62.38 ^{cd}	64.69 ^{bc}	73.80 ^a	70.49 ^{ab}	1.63
†NH ₃ ppm/100 ml·min ⁻¹	357.88	178.21 ^f	63.48 ^f	70.31 ^f	339.06	23.01

^{a,b,c,d,e}Least square means in rows with different superscript are significantly different ($P < .05$). †Ammonia production preplanned comparisons are 15% CP vs 12% CP+CAA, 15% CP vs 9% CP+CAA, 15% CP vs 6% CP+CAA, 15% CP vs Casein, 15% CP vs Protein-free. ‡Least square means in rows with same superscript are highly significantly different ($P < .001$)

Key Words: Nitrogen retention, Ammonia production, Pigs

183 Amino acids fortified corn diets for late-finishing barrows. H. Liu*, G. L. Allee, E. P. Berg, K. J. Touchette, J. D. Spencer, and J. W. Frank, *University of Missouri-Columbia*.

One hundred and twelve late-finishing barrows (LFB) (85.2 kg) were used in an experiment to evaluate the role of isoleucine or valine in amino acid (AA) fortified all-corn diets on growth performance and carcass characteristics of LFB. There were four treatments. The control diet (diet 1) was formulated with corn and soybean meal to contain .52% true ileal digestible Lys (TDL). Diet 2 was corn fortified with .43% L-Lys.HCl, .15% L-Thr, .06% L-Trp, .04% DL-Met, .13% L-Ile, and .11% L-Val. Diet 3 was the same diet as 2 except L-Ile was replaced by corn starch. Diet 4 was the same as diet 2 except that L-Val was replaced with corn starch. The control diet and all the low-protein diets contained the same levels of TDL. Analyzed protein levels were 13.1% for the control diet and 7.1% for the low-protein diets. Pigs were weighed and feed consumption was recorded on wk 0, 2, 4 and 5. Real-time ultrasound was used to measure backfat (BF) and loin eye area (LEA). At the end of the growth experiment (115.5 kg), eight pigs from treatment 1 and 2 were slaughtered to evaluate the carcass characteristics, including BF, LEA, loin eye protein and fat content. No differences were found in final body weight (BW), ADG, ADFI, gain/feed ratio (G/F), BF, LEA, loin eye protein or fat content between pigs fed diet 1 and diet 2. Pigs fed diet 3 (-Ile) had significantly lower ($P \leq .01$) BW, ADG, ADFI and G/F than pigs fed diet 1 or 2. Pigs fed diet 4 (-Val) had significantly lower ($P \leq .05$) BW than pigs fed diet 1, but higher ($P \leq .01$) BW, ADG, and ADFI than pigs fed diet 3. This experiment indicates that LFB fed an all-corn diet fortified with AA can have the same performance as pigs fed a corn-soybean meal control diet. Deleting isoleucine from the all-corn AA fortified diet decreases pigs performance dramatically. Valine seems to be marginal limiting in an all-corn diet for LFB, but isoleucine is much more limiting than valine.

Key Words: Finishing pig, Isoleucine, Valine

184 Effect of reducing protein and adding amino acids on performance, carcass characteristics, and nitrogen excretion, and the valine requirement of early-finishing barrows. H. Liu*, G. L. Allee, K.J. Touchette, J. W. Frank, and J. D. Spencer, *University of Missouri-Columbia*.

A total of 193 early-finishing barrows (EFB) were used in 3 experiments to evaluate the effect of reducing dietary CP levels by 5% and adding amino acids (AA) on performance, carcass characteristics, and nitrogen (N) excretion, and the valine requirement of EFB. In Exp. 1, 25 barrows (52.0 kg) were used to estimate the lysine requirement of EFB using plasma urea N (PUN) so that we could formulate diets according to their lysine requirement. Pigs fed .70% true digestible lysine (TDL) had lower PUN level ($P \leq .10$) than pigs fed .60% TDL. Increasing TDL level beyond .70% had no effect on reducing PUN level. In Exp. 2, 150 barrows (59.8 kg) were used to evaluate the effect of reducing CP level by 5% and adding AA including different levels of Val on pig performance and carcass characteristics. The control diet was a corn-soybean meal diet formulated to contain .70% TDL, with a CP level of 15.4%. The other five diets were formulated to contain 10.4% CP, and were fortified with L-Lys, L-Thr, L-Trp, DL-Met, L-Ile and different levels of L-Val (0, .05, .10, .15, and .20%). Pigs fed the control diet and the low-protein, AA fortified diets had no significant difference in ADG, ADFI, gain/feed, back fat depth, and the loin eye area. Adding increasing levels of Val had no effect on pig performance or carcass characteristics. True digestible Val (TDV) level in the low-protein diet with no added Val was .37% which resulted in 11.4 g/d at the feed intake of 3.1 kg/d. In Exp. 3, 16 barrows (70.0 kg) were used to evaluate the effect of reducing CP and adding AA on N excretion. Decreasing CP by 5% decreased urinary N excretion by 49.2%, and total N-excretion by 40.6%. These results indicate that N excretion of EFB can be reduced by decreasing CP level by 5% and adding AA while maintaining pig performance and

carcass characteristics. The TDV requirement of EFB appears to be no greater than 11.4 g/d and is not limiting in this low-protein diet.

Key Words: Low-protein, Finishing pigs, Valine

185 Effect of dietary protein and carbohydrates on internal nitrogen flow and excretion patterns in growing pigs. S. Zervas*^{1,2} and R.T. Zijlstra¹, ¹*Prairie Swine Centre Inc.*, ²*University of Saskatchewan, Saskatoon, Canada*.

Successful nutrient management is important for sustainable pork production. Nitrogen (N) is of major concern because of its impact on inside and outside barn environment. The experiment had 2 objectives: (1) to study the effect of crude protein (CP) and fiber (CF) on N excretion patterns and (2) to relate plasma urea nitrogen (PUN) to urinary N excretion. Three levels of CP (high, 19.5%; medium, 16.5%; low, 13.6%) and two levels of CF (high, 5.1%; low 3.6%) were tested in a 3x2 factorial arrangement for a total of six treatments with 42 pigs. Diets (wheat, barley, soybean meal; oat-hulls as a CF source) were formulated to 3250 kcal DE/kg and 2.18 g dLys/Mcal, supplemented with Lys, Met, Trp, Thr, Iso, or Val to maintain a similar content of digestible amino acids. Pigs (32±3.4kg) were housed in confinement-type metabolism crates for 19 d. On d 10 or 11, catheters were installed by cranial vena cava venipuncture. Feces and urine were collected from d 15 to 19. Five blood samples were collected in two-h intervals (starting before feeding) on d 16 and d 19. Fecal N was reduced 22.8% for low CP and 14.3% for medium CP compared to high CP diets ($P < .01$). Urinary N was reduced 47.9% for low CP and 19.8% for medium CP compared to high CP diets ($P < .01$). Total N retention was reduced 2.3g/d for medium CP versus high CP diets and 1.8g/d for low versus medium CP diets ($P < .01$), but N retention as a percentage of N intake was higher for low CP compared to high and medium CP diets ($P < .01$). Fecal N was increased 9.2% ($P < .10$) for high versus low CF diets but urinary N was not affected ($P > .10$). Dietary treatments did not affect ADG and feed efficiency (FE; $P > .10$). Urinary N was correlated against the PUN ($R^2 = .65$; $P < .001$) suggesting that urinary N excretion can be predicted from PUN concentration. In conclusion, reduction of CP is effective to reduce N excretion, especially urinary N. Although ADG and FE were not affected by reducing dietary CP, further research is required to maintain protein deposition.

Key Words: Pig, Nitrogen excretion, Plasma urea nitrogen

186 Response of grower-finisher pigs to declining energy intake at constant or proportional daily amino acid intake levels. C. M. Nyachoti*¹, J. F. Patience¹, R. T. Zijlstra¹, D. Gillis¹, R. D. Boyd², and J. Usry³, ¹*Prairie Swine Centre Inc.*, *Saskatoon, Canada*, ²*PIC, USA, Franklin, KY*, ³*Heartland Lysine, Chicago, IL*.

The response of grower-finisher pigs to decreasing energy intake (DE_i) when amino acids (AA) are maintained at a constant daily intake or at the same dietary concentration relative to DE was investigated in two experiments involving 126 PIC barrows within 30 to 60 (Exp. 1) and 85 to 110 kg BW ranges (Exp. 2). Pigs were penned individually and fed one of seven dietary treatments (ad libitum or 87%, 74% and 63% of ad libitum each with AA intake maintained at a constant daily intake or at the same dietary concentration relative to DE_i) in a completely randomized block design. For each experiment, two diets based on wheat, barley and soybean meal were formulated to a similar DE but AA, minerals and vitamins in the second diet were increased to maintain a constant daily AA, mineral and vitamin intake. Feed intake was adjusted weekly. BW was determined weekly and pigs were scanned by Real Time Ultrasound at the beginning and end of experiments to estimate rates of protein (PD) and lipid (LD) deposition. Carcass data was collected at the end of the finisher trial. ADG, PD and LD decreased with decreasing DE_i and were unaffected by the level of AA consumed ($P > .10$). In Exp. 1, feed efficiency (FE) was similar ($P > .10$) among treatments with DE_i ranging from ad libitum to 74% of ad libitum intake. In Exp. 2, pigs fed at 100% and at 61% of ad libitum intake had the highest and lowest FE, respectively, compared to the other treatments ($P < .05$). Those fed at 87% and 74% of ad libitum intake had similar and intermediate FE. The amount of AA consumed relative to DE_i had no effect ($P > .10$) on FE in both experiments. Carcass data showed no advantage of either amino acid regimen. As expected, low DE_i pigs had leaner and higher yielding carcasses. Grower and finisher pigs respond similarly to declining DE_i whether intake of AA is held at a constant daily level or maintained at a constant ratio to energy.

Key Words: Energy intake, Daily amino acid intake, Pigs

187 Effects of lysine level fed from 19 to 36 kg on growth performance and backfat of barrows and gilts. B. W. James*, S. S. Dritz, M. D. Tokach, R. D. Goodband, and J. L. Nelssen, *Kansas State University*.

Growth performance and carcass traits were evaluated on 1,200 pigs (PIC C-22 x 337) to determine the effects of dietary lysine level fed from 19 to 36 kg. Pigs were blocked by gender in a split plot design. Gender served as the whole plot with dietary treatments assigned within the subplot. Weights and feed intake were obtained biweekly. Ultrasound measurements of 10th rib fat depth and longissimus muscle area were obtained on d 28. Experimental diets were assigned for the first 28 d of the experiment. Corn-soybean meal diets, containing 6% choice white grease, were formulated to contain .80, .95, 1.10, 1.25, or 1.40% total lysine. Common corn-soybean meal diets containing 6% choice white grease (1.25% and 1.10% lysine for gilts and barrows, respectively) were fed for a subsequent 28-d phase from d 28 to 56. Increasing dietary lysine from .80 to 1.40% increased (quadratic, $P < .01$) ADG and feed efficiency (G:F) during the treatment phase (.56, .60, .66, .66, and .68 kg and .55, .62, .64, .65, and .68, respectively). The greatest response in ADG and G:F occurred as lysine was increased from .80 to 1.10%; however, G:F continued to improve with every incremental increase in lysine. Longissimus muscle area was not affected by dietary lysine. Fat depth at the 10th rib decreased (quadratic, $P < .02$) as lysine level increased with the largest reduction observed as lysine increased from .80 to .95% of the diet (4.1, 3.3, 3.6, 3.3, and 3.3 mm). Subsequent performance from d 28 to 58 was not influenced by lysine level fed from d 0 to 28 of the experiment. The results of this experiment indicate the slight improvement in G:F at higher lysine levels offset the increase in diet cost to result in similar return over feed cost. Thus, diets for pigs weighing 19 to 36 kg can be formulated with a dietary lysine level ranging from 1.10 to 1.40% lysine with similar economic results.

Key Words: Lysine, Growth, Carcass characteristics

188 Nutritional modifications to late finishing swine diets during periods of high ambient temperatures in a commercial production system. J. D. Spencer*¹, G.L. Allee¹, N. Allen², J. Usry³, R.D. Boyd⁴, and M.E. Johnston⁴, ¹University of Missouri-Columbia, ²Goldsboro Milling Co., ³Heartland Lysine, ⁴PIC-USA.

Nutritional modifications were made to late finishing swine diets in a commercial swine operation to determine the effects on growth performance and carcass characteristics when pigs were exposed to high ambient temperatures. One barn of 588 gilts (87 kg), and one barn of 588 barrows (89 kg) each contained four treatments with seven replications (pens)/trt. Treatments consisted of: 1) a high heat increment diet with 15% wheat midds, 2) a corn/SBM diet with 2% added fat, 3) diet with 8% added fat to reduce the heat increment, 4) diet with 8% added fat and amino acids (AA) to the same true digestible lysine to ME ratio as the control. Initially and at the end of the trial, five pigs/pen in both barns were scanned for 10th rib backfat (BF) and loin depth. All barrows were individually weighed to determine treatment effects upon weight variation within pen. Termination for each barn occurred when the pigs within the barn approached 113 kg. Temperatures were high the first two weeks, but the remainder of the study was cooler than expected. During the first two weeks of growth (ave. high temp. 32.4°C) pigs fed diet 4 in both barns displayed higher ADG and GF ($P \leq .01$) than all other treatments. However after temperatures decreased, pigs fed diets 3 and 4 both displayed improved GF compared to pigs fed diets 1 and 2 by reducing ADFI for the entire period. Pigs fed high fat supplemented diets had slightly higher depositions of BF. However gilts fed diet 4 with added AA had less BF compared to those fed a diet with only supplemental fat (3) ($P \leq .13$). Variation within pen was decreased when pigs consumed diets containing added fat and AA (4) ($P \leq .07$). These results show that reducing the heat increment of the diet by adding fat and adjusting for lysine content improves the rate and efficiency of gain during high temperatures in a commercial operation, with improved uniformity among pig weights.

Key Words: Pig, Growth, Temperature

189 Predicting lysine requirements of finishing pigs using protein and lipid accretion curves. M. De La Lata*¹, M.D. Tokach¹, S.S. Dritz¹, R.D. Goodband¹, J.L. Nelssen¹, and A.P. Schinckel², ¹Kansas State University, Manhattan, ²Purdue University, West Lafayette, IN.

Two experiments using 240 gilts and 240 barrows (PIC C22 x 337) with initial BW of 27 and 34 kg, respectively, were conducted to model the lysine:calorie ratio requirements of grow-finish pigs based on protein and lipid accretion rates from estimations made using real-time ultrasound. In both experiments, pigs used were selected from an ongoing growth study. The dietary treatments consisted of a 2 x 4 factorial with 2 levels of added dietary fat (0 and 6%) and four lysine:calorie ratio regimens in each of the four phases (described in *J. Anim. Sci.* 77(Suppl. 1):197). In each study, five pigs per pen from a total of 48 pens were randomly selected, weighed, tagged, and scanned every 3 weeks until pigs were marketed at an average weight of 120 kg. Growth and real-time ultrasound data were used to calculate daily body weight gain and lipid and protein accretion rates. Subsequently, daily requirements for ME and total lysine were calculated to model lysine:calorie ratio requirements. In both experiments, protein and lipid accretion rates were greater for the third and fourth lysine:calorie ratio regimens. In both experiments, the treatments with greater protein accretion (third and fourth lysine:calorie ratio regimens) and, thus, with greater requirement for total lysine also demonstrated increased lysine:calorie requirements when compared to the first and second lysine:calorie ratio regimens. In both experiments, the modeled lysine:calorie ratios accurately predicted the actual lysine:calorie ratio requirements observed in the growth performance experiment. These results indicate that real-time ultrasound can be used to accurately predict growth and lysine:calorie ratio requirements for grow-finish pigs reared in specific environments. Lysine:calorie ratio requirements (g/Mcal ME) for pigs used in this experiment can be determined at any body weight (x; kg) by the regression equations ($0.00019x^2 - 0.05635x + 5.499$) for gilts, and ($0.000049x^2 - 0.037319x + 4.929$) for barrows.

Key Words: Pigs, Lysine, Ultrasound

190 Nitrogen and phosphorus excretion from pigs fed different soybean fractions. B.W. Senne*, S.D. Carter, L.A. Pettey, and J.A. Shriver, *Oklahoma State University, Stillwater*.

Six sets of four littermate barrows (40 kg BW) were used to determine N and P excretion of pigs fed different soybean fractions. Treatments were cornstarch-based diets with either SBM, SBM + 4% hulls (SBMH), soy protein concentrate (SPC), or soy protein isolate (SPI) used as source of N. All diets were formulated to contain .75% digestible lysine, .61% Ca, and .32% available P. Crystalline Met and Thr were added to provide an ideal ratio to lysine in all diets. Pigs were housed individually in metabolism chambers and fed diets for 5 d to allow for total collection of urine and feces. Rate and efficiency of gain were not affected by dietary treatment. Dry matter excretion (55, 102, 59, and 41 g/d) was highest ($P < .01$) for pigs fed SBMH. Pigs fed SPC excreted more ($P < .07$) DM compared with pigs fed SPI. Daily N and P intakes were 38.1, 38.7, 34.2, and 32.9 g; and 10.8, 11.9, 8.1, and 5.7 g/d for pigs fed SBM, SBMH, SPC, and SPI, respectively. Fecal N, urinary N, and total N excretion for the 4 diets was 3.3, 5.2, 2.6, and 1.5 g/d; 8.2, 8.2, 7.7, and 7.4 g/d; and 11.5, 13.6, 10.2, and 8.9 g/d. Nitrogen absorption (% of intake) was higher ($P < .01$) for pigs fed SBM compared with pigs fed SBMH. Pigs fed SPI absorbed more ($P < .01$) N than pigs fed SBM or SPC. Retained N (% of intake) was lower ($P < .10$) for pigs fed SBMH compared with SBM, and pigs fed either SPC or SPI retained more N ($P < .03$) than pigs fed SBM. Fecal P excretion for the four diets was 2.1, 2.9, 2.1, and 1.8 g/d. Urinary P excretion was minimal across treatments, thus total excretion of P was similar to fecal P. Excretion of P (g/d) was greater ($P < .01$) for pigs fed SBMH compared with all other dietary treatments. Retention of P (% of intake) was lowest for pigs fed SPI ($P < .04$); however, there were no differences among any other treatments. These results suggest that retention of N increases and excretion of N decreases as level of refinement increases for soybeans. Furthermore, the addition of soybean hulls to SBM increases DM, N and P excretion while decreasing N retention.

Key Words: Nitrogen, Phosphorus, Excretion

191 Effects of adding fiber sources to low protein, amino acid-supplemented diets on nitrogen excretion and performance of finishing pigs. J.A. Shriver*, S.D. Carter, L.A. Petty, and B.W. Senne, *Oklahoma State University, Stillwater.*

Two experiments were conducted to determine the effects of fiber addition to low protein, amino acid-supplemented diets on N balance and growth performance of finishing pigs. In Exp. 1, six sets of four littermate barrows (40 kg) were allotted to four dietary treatments. Treatments were: (1) fortified corn-SBM control, (2) as 1 with CP reduced by 4% units + Lys, Met, Thr, Trp, Ile, and Val (LPAA), (3) as 2 + 10% soybean hulls (SBH), and (4) as 2 + 10% beet pulp (BP). Crystalline amino acids were added to Diets 2-4 on an ideal basis. All diets were formulated to .78% digestible lysine. Pigs were housed individually in metabolism chambers, and diets were fed (ad libitum) for 5 d to allow for total collection of urine and feces. Daily N intakes averaged 58.4, 43.8, 46.3, and 45.5 g for the four dietary treatments, respectively. Total N excretion was reduced by 49% in pigs fed LPAA as compared with the control (23.1 vs 11.9 g/d, $P < .01$). Addition of SBH or BP to LPAA did not affect total N excretion, but tended to reduce urinary urea N. Nitrogen retention (g/d) was not affected by dietary treatment. Addition of SBH or BP to LPAA had little effect on overall N balance. In Exp. 2, 72 pigs, initially weighing 32 kg, were blocked by BW and sex, and allotted randomly to three dietary treatments (six pens/trt of four pigs/pen). Dietary treatments were similar to Diets 1-3 (control, LPAA, and SBH) used in Exp 1. Pigs were fed in three phases (32-59, 59-86, and 86-113 kg). Total lysine was .95, .80, and .67% for the three phases, respectively. Pigs and feeders were weighed at 2-wk intervals for determination of ADG, ADFI, and G:F. ADG and G:F were, respectively: .81, .78, and .78 kg; and .36, .35, and .35. Reducing CP and adding AA or the addition of SBH to LPAA did not affect growth performance. These results suggest that reducing CP and adding amino acids reduces N excretion without adversely affecting performance. Addition of fiber sources to LPAA did not affect N balance or growth performance.

Key Words: pigs, nitrogen excretion, dietary manipulation

192 Effect of soy isoflavones on growth and carcass traits of growing finishing barrows. R. L. Payne*, T. D. Bidner, and L. L. Southern, *Louisiana State University Agricultural Center.*

An experiment was conducted with 36 barrows (initial and final BW, 26 and 113 kg) to determine the effect of soy isoflavones (ISF) on growth and carcass traits. The treatments (four replications of three pigs) were: 1) corn-soybean meal (C-SBM), 2) corn-soy protein concentrate (low isoflavone, C-SPC), and 3) C-SPC + ISF (ISF levels equal to those in C-SBM). The SBM, SPC, and ISF (Central Soya, Inc.) contained 1135.3, 57.5, and 29,353.0 mg/kg of total isoflavone [SBM, SPC, and ISF: daidzein (.54, .03, and 1.82 mg/g), glycitein (.15, .00, and .00 mg/g), and genistein (.45, .03, and .45 mg/g) normalized for aglycone content]. Diets were formulated to provide .87, .70, and .55% true digestible lysine levels for the grower (26 to 49 kg), early finisher (49 to 78 kg), and late finisher (78 to 113 kg) periods. The total ISF levels in the C-SBM and C-SPC+ISF diets for these periods were: grower (272.0 mg/kg), early finisher (177.0 mg/kg), and late finisher (108.3 mg/kg). Growth performance was not affected ($P > .10$) by diet, other than a reduction ($P < .10$) in ADG and ADFI in pigs fed the C-SPC+ISF relative to pigs fed the C-SPC diet in the late finisher period. Weights of carcass muscle and fat were estimated by TOBEC[®] of the ham. Loin muscle area, 10th rib 3/4 fat depth, percentage of muscling (NPPC), 24 h pH and temperature, color, firmness, marbling, drip loss, and Minolta L*, a, and b color values were not affected ($P > .10$) by diet. Using final BW as a covariate, dressing percentage, fat-free lean, lean gain per day, and percentage lean were increased ($P > .10$) and percentage fat was decreased ($P < .10$) in pigs fed the C-SPC+ISF diet compared with pigs fed the C-SPC diet. Pigs fed the C-SPC+ISF diet had similar ($P > .10$) carcass traits as pigs fed the C-SBM diet, except percentage ham lean was greater and total ham fat was less in pigs fed the C-SPC+ISF. These data indicate that ISF did not affect growth performance or meat quality of barrows, but it did increase lean and decrease fat content.

Key Words: isoflavone, pig, growth

193 Effect of sucrose on growth, carcass traits, and meat quality in growing-finishing pigs. L. K. Camp*, L. L. Southern, and T. D. Bidner, *Louisiana State University Agricultural Center.*

An experiment was conducted to determine the effect of dietary sucrose on growth performance, carcass traits, meat quality, and serum urea nitrogen concentrations in growing-finishing pigs. Pigs were allotted to three dietary treatments (0, 7.5, and 15.0% sucrose) with three replications of four barrows and three replications of three or four gilts each. Average initial and final weights of the pigs were 25.2 and 106.7 kg, respectively. A three phase feeding program was used, and corn-SBM diets were formulated to provide 105% of the NRC lysine requirement for barrows or gilts with a lean gain per day of 325 g. All amino acids exceeded the NRC requirement. All diets contained equal levels of NE within each phase for each sex. Net energy values used for corn, SBM, sucrose, and dry fat were 2,295, 2,020, 2,730, and 5,095 kcal/kg, respectively. Average daily gain and gain:feed were linearly increased ($P = .02$) by sucrose, but ADFI was not affected ($P > .10$). Loin muscle area, 10th rib 3/4 backfat thickness, dressing percentage, fat-free lean, percentage lean, lean gain per day, total fat, percentage fat, lean:fat ratio, 45-min pH and temperature, 24-h pH and temperature, serum urea nitrogen concentration, and NPPC color, firmness/wetness, and marbling scores were not affected by diet ($P > .10$). Minolta color a and b values were increased by sucrose ($P < .05$), but the L* value was not affected ($P > .10$) by sucrose. Drip loss was linearly increased by sucrose ($P = .06$). In summary, feeding sucrose to growing finishing pigs improved growth performance and did not affect carcass traits, but it increased drip loss.

Key Words: pig, sucrose, carcass

194 Boron supplementation improves performance and inflammatory response in pigs. T.A. Armstrong* and J.W. Spears, *North Carolina State University, Raleigh, NC.*

An experiment was conducted to evaluate the effectiveness of long-term boron (B) supplementation on growth and immune status of pigs. Fifty weanling gilts were randomly allotted to receive either a basal diet or the basal diet with 5 ppm supplemental B. Animals remained on their respective dietary treatments throughout the nursery, growing, and finishing periods (154 d). Gain, intake, and feed efficiency were determined at the completion of each phase of production. Measures of immune status were evaluated beginning at d 95 of the experiment. The blastogenic response of cultured lymphocytes to phytohemagglutinin (PHA), concanavalin A (ConA), and pokeweed mitogen (PWM) stimulation was measured. In addition, an in vivo assessment of the cell-mediated immune response was determined by measuring the change in skinfold thickness following an intradermal injection of PHA at two separate sites. The humoral immune response was determined by measuring the hemagglutination titers of serum from pigs injected with a 20% sheep red blood cell (SRBC) solution. Performance was not affected by B supplementation during the nursery or growing phases. However, B supplementation did improve ($P < .05$) gain during the finishing phase and over the entire grow-finish period. Intake tended ($P = .11$) to be increased and feed efficiency was not affected by treatment. The blastogenic response of cultured lymphocytes to PHA, ConA, and PWM were not affected by B supplementation. The inflammatory response was decreased ($P < .05$) by B supplementation, which may indicate a decrease in tissue damage. Gilts supplemented with 5 ppm B had IgM titers specific for SRBC that tended to be higher ($P = .08$) than the control gilts at d 14 post-injection of SRBC. There were no effects of B supplementation on total Ig, IgG, or IgM titers specific to SRBC at d 7 and 21 post-injection. Therefore, it appears that B may benefit the swine industry, due to its growth enhancing potential and its potential to reduce inflammation in pigs.

Key Words: Boron, Pigs, Inflammatory response

195 Hair measurements as an indicator of selenium status of pigs. Y. Y. Kim* and D. C. Mahan, *Ohio State University, Columbus.*

Previous observations studying the toxicity effects of inorganic and organic Se indicated that pigs with white hair were more affected by selenosis conditions than dark haired pigs. Three studies were therefore conducted to evaluate the effect of Se level, Se source, and hair color

on various hair measurements in growing finishing pigs and reproducing sows. The first experiment was a 2 x 6 factorial arrangement conducted as a RCB in two replicates with measurements collected over time. A total of 48 crossbred pigs of varying hair colors were fed treatment diets for a 14 wk period. Inorganic and organic Se sources were added at .3, 1, 3, 5, 7 and 10 ppm Se. Hair samples were collected from the dorsal-midline of white and red haired pigs at 4, 6, 10, 12, and 14 wk and analyzed for Se and amino acids. Hair Se concentration increased as dietary Se level increased ($P < .01$), over time ($P < .01$), and highest when pigs were fed organic Se ($P < .05$). Selenium concentration in red hair was higher than white hair ($P < .01$) even when both hair colors were present on the same pig. Amino acid compositions were similar for both hair colors, Se sources and Se levels. The second experiment evaluated the hair Se content of nine gilts at 9 mo. of age that had been fed diets with .3 ppm inorganic Se. Hair samples were collected from the shoulder, back, rump, front-leg, bacon, and hind-leg and washed of residue. Hair Se concentrations in the lower body extremities were higher ($P < .05$) than hair from the upper body. Hair diameter did not differ by body location. The third experiment analyzed hair samples collected from a total of 72 sows from two commercial sow herds from parity 1 to 6 that had been fed .3 ppm Se. Hair Se concentration decreased linearly ($P < .01$) as sow parity increased. These results suggest that hair Se may be a good indicator of the pigs Se status, and that pig genetics, and longevity in the reproducing herd may affect the Se status of the herd and the pig's Se requirement.

Key Words: Selenium, Hair, Pigs

196 Effects of adding and removing dietary fat on growth performance and carcass characteristics of pigs from 25 to 120 kg. M. De La LLata*, M.D. Tokach, S.S. Dritz, R.D. Goodband, and J.L. Nelssen, *Kansas State University, Manhattan*.

A total of 525 barrows and 525 gilts (PIC C22 x 337) with an initial weight of 25 kg were used to determine the carryover effects of adding and removing dietary fat on growth performance and carcass characteristics. Barrows and gilts were blocked by gender and weight and allotted to one of six dietary treatments in a randomized incomplete block design with 25 pigs/pen. The corn soybean meal-based diets contained either 0 or 6% choice white grease and were fed in four phases. The dietary treatments consisted of six different sequence arrangements of the diets across the four phases. The phases were 25 to 45, 45 to 70, 70 to 90 and 90 to 115 kg. The six diet sequence arrangements expressed as percent added fat for the four phases, respectively were 0,0,0,0; 6,6,6,6; 6,0,0,0; 6,6,0,0; 6,6,6,0; and 0,6,0,6. During phase 2, ADG was increased ($P < .01$) for the added fat treatments. For the overall experiment, ADG was not affected ($P > .44$) by dietary treatments. During every phase, G/F was increased ($P < .01$) for treatments containing 6% added fat, regardless of the dietary fat level fed in the previous phase. Treatments containing 6% added fat in three phases or in all phases had the greatest ($P < .05$) G/F. Treatments containing no added fat or only during phase 1 had the lowest ($P < .05$) G/F. Treatments containing added fat during 2 phases had intermediate feed efficiency. Back-fat depth was increased ($P < .05$) and FFLI decreased ($P < .05$) for the dietary treatment containing 6% added fat in all phases with no differences ($P > .50$) observed among the rest of the treatments. The FFLI for the six treatments were 49.4, 48.6, 49.3, 49.5, 49.3, and 49.1, respectively. The results from this experiment indicate that no carryover effect exists by adding and removing dietary fat during the different phases, and that the best overall performance was obtained when adding 6% fat during the first three phases of growth.

Key Words: Finishing pigs, Fat, Carryover

197 Economics of adding fat and increasing lysine:calorie ratio in diets for gilts from 27 to 120 kg. M. De La LLata*, M. Langemeier, S.S. Dritz, M.D. Tokach, R.D. Goodband, and J.L. Nelssen, *Kansas State University, Manhattan*.

Growth performance data from a total of 1,200 gilts (PIC C22 x 337; initially 27 kg) were used to evaluate income over feed cost from various dietary lysine regimens. Pigs were allotted to one of eight dietary treatments with 25 pigs/pen and six pens/treatment. A total of 64 income over feed cost alternatives were created from the combination of eight dietary treatments, four scenarios for ingredient and hog base prices,

and two different packing plant grids. The eight dietary treatments were fed in four phases and consisted of corn-soybean meal-based diets arranged in a 2 x 4 factorial with 0 or 6% added fat and four increasing lysine:calorie ratios in each phase (as described in J. Anim. Sci. 77(Suppl. 1):197). The prices used were corn at \$.075/kg for scenarios 1,2,3, and \$.104/kg for scenario 4, soybean meal at \$143/tonne for scenarios 1,2,3, and \$194/tonne for scenario 4, choice white grease at .265, .441, .220, and \$.331/kg for scenarios 1,2,3, and 4, respectively, and hog base carcass at \$90.6/100 kg for scenarios 1,2,3, and \$152.8/100 kg for scenario 4. The marketing grids were fixed premiums and discounts for grid 1 and an index representing a percentage of hog base price for grid 2. Data were analyzed using first and second-degree stochastic dominance to indicate preferred scenarios based on profit and risk. Using grid 1, the fourth lysine:calorie ratio regimen with added fat was the preferred alternative for the low fat price scenarios. The fourth lysine:calorie ratio regimen without added fat was the preferred alternative for the high fat price scenario. Using grid 2, the third and fourth lysine:calorie ratio regimens with added fat were the preferred alternatives for the low fat price scenarios, and the fourth lysine:calorie ratio regimen with or without added fat were the preferred alternatives for the high fat price scenario. Adding fat to the diets increased feed cost per unit of gain, but resulted in heavier carcasses with an increased income over feed cost in all scenarios except for the one using high cost fat.

Key Words: Gilts, Fat, Economics

198 Effects of different sources of phosphorus and calcium on urine pH and ammonia emission. I.B. Kim*, D.H. Kim, P. Ferket, and T. van Kempen, *North Carolina State University, Raleigh, NC*.

Three trials were conducted to evaluate the effects of different sources of phosphorus and calcium on ammonia emission of swine manure. Dicalcium phosphate (DCP), monocalcium phosphate (MCP), and phosphoric acid (PA) were used as the supplementary phosphorus sources. The calcium sources used limestone (L; CaCO₃) and calcium sulfate (CS; CaSO₄). In Exp. 1, eight crossbred barrows (initial BW 67.4 kg) were used for measuring urine pH. Dietary treatments were control (DCP+L), MCP (MCP+CS), PA (PA+CS), and HCl (L+CS+HCl) diet. All diets were formulated to be equal in calories, nitrogen, phosphorus, and calcium. Treatments were tested in a Latin Square design (LSD). Free access to water was provided and 80 g feed on each kg metabolic BW was given twice daily, at 0600 and 1800. After a 5-day adaptation, urine samples were collected. In urine pH, PA and MCP diet (5.85.38 and 5.73.30) decreased compared to control (6.86.24; $P < .05$). In Exp. 2, twenty growing barrows (BW 22.5 kg) were allotted to two respiration chambers. These chambers were used for determining the effect of two dietary calcium sources (L and CS) on ammonia emission. Treatments were allotted using a cross-over design. Feed and water were provided ad libitum. Ammonia emission was monitored semi-continuously using FTIR over 7 days after 7-day adaptation. The CS diet increased ammonia (1%) compared with control. Exp. 3 (BW 43.1 kg) was conducted as Exp. 2 for determining the effect of two dietary phosphorus sources (DCP+L and PA+CS diet). The PA+CS diet decreased the overall ammonia emission (30%, $P < .05$). Therefore, replacing dicalcium phosphate in the diet with phosphoric acid results in a decrease in urine pH that leads to reductions in ammonia emission.

Key Words: Phosphorus, Calcium, Ammonia emission

199 Odor characteristics of swine manure and nutrient balance of grow-finish pigs fed diets with and without distillers dried grains with solubles. M.J. Spiehs*, M.H. Whitney, G.C. Shurson, and R.E. Nicolai, *University of Minnesota, St. Paul*.

A 10-wk trial was conducted to determine odor characteristics of swine manure and energy, nitrogen, and phosphorus balance of grow-finish pigs fed diets with and without distillers dried grains with solubles (DDGS) from ethanol plants in the Minnesota-South Dakota region. Sixteen PIC barrows weighing 57.5 4.1 kg were randomly assigned to one of two dietary treatments (8 pigs/treatment): control (0% DDGS) and 20% DDGS. A three-phase diet sequence was fed. Total lysine and P levels were identical for diets in each phase. Manure from each pig in collection cages was collected daily except during the last 3 d of wks 2, 6, and 10, when total fecal and urine collection was conducted for the nutrient balance measurements. Urine and feces were mixed and emptied into

simulated pits according to dietary treatment. Air samples were collected weekly from each simulated pit and analyzed for H₂S and NH₃. Air samples collected during weeks 2, 5, and 8 were evaluated for odor. Dietary treatment had no effect on H₂S, NH₃, or odor detection levels (P > .10) over the 10-wk trial. Pigs fed the DDGS diets had greater N and GE intake in all three phases (P < .01) but ADFI was not different among treatments. DE and ME (kcal/kg) did not differ among diets (P > .15). Nitrogen retention (%) was not different between dietary treatments, but feeding DDGS increased N excretion during all three phases (P < .10). Phosphorus retention (%) was not different between dietary treatments (P > .15), but urinary P excretion tended to decrease (P < .15) when DDGS diets were fed during phases 2 and 3. These results suggest that feeding 20% DDGS does not reduce H₂S, NH₃, and odor levels over a 10-wk manure storage period. Feeding DDGS increases GE intake and improves P utilization during late finishing phases, but also increases N excretion.

Key Words: Pigs, Distillers dried grains with solubles, Odor

200 Effects of processing on nutritional value of normal and high-oil corn in nursery pigs. L.J. McKinney*, J.D. Hancock, K.C. Behnke, D.W. Dean, C.W. Starkey, and J.M. DeRouchey, *Kansas State University, Manhattan.*

A total of 384 weanling pigs (average initial BW of 6.5 kg) were used to determine the effects of grinder type, corn genotype, and corn particle size on growth performance. The pigs were blocked by weight and allotted to pens based on sex and ancestry. There were six pigs per pen and eight pens per treatment. Treatments were No. 2 yellow dent corn (C) and high-oil corn (HOC), ground through a hammermill or roller mill to medium (771 microns) and fine (474 microns) particle sizes. Corn oil was added to C diets to maintain a constant ether extract in all diets. The diets were fed in pelleted form. Interactions among the main effects of grinder type, genotype, and particle size were few and inconsistent. Grinder type (hammermill versus roller mill) did not affect growth performance (P > .4). Rate of gain was not affected by corn genotype (P > .39), but pigs fed HOC from d 7 to 14 had greater (P < .04) gain/feed. However, gain/feed was not affected (P > .36) by corn genotype for d 14 to 33 or overall (d 0 to 33). The similar growth performance of pigs fed C and HOC was not surprising because the diets were formulated to have the same percentage ether extract. For d 0 to 7, ADG and ADFI increased (P < .072) as particle size was reduced. However, the benefits in ADG from reducing particle size were greater for pigs fed C versus HOC (genotype × particle size, P < .10). Overall (d 0 to 33), particle size did not affect ADG, ADFI, or gain/feed (P > .5). Thus, we conclude that when diets for nursery pigs are formulated to a similar fat content then grinder type, corn genotype, and corn particle size have minimal effects on growth performance.

Item	Hammermill				Roller mill				SE
	C		HOC		C		HOC		
	Med.	Fine	Med.	Fine	Med.	Fine	Med.	Fine	
Overall									
ADG, g	500	501	517	517	515	510	498	509	10
ADFI, g	642	623	639	647	621	635	631	647	14
Gain/feed, g/kg	779	804	809	799	829	803	789	787	17

Key Words: High oil corn, Particle size, Pigs

201 Ileal starch, apparent protein, and true protein digestibility of different corn hybrids fed to growing pigs. L. L. Andersen*¹, J. L. Snow², P. K. Ku¹, H. H. Stein³, M. Allen¹, and N. L. Trottier¹, ¹Michigan State University, East Lansing, ²University of Illinois, Urbana, ³FAF Minatech A/S, Odense, Denmark.

Eight barrows (40 kg) were used in an 8 × 8 Latin square design to compare ileal starch, apparent protein, and true protein digestibility between different corn hybrids, i.e., waxy (WX) vs isogenic waxy (IWX), high-oil (HO) vs isogenic high-oil (IHO), high-lysine (HL) vs a normal corn with a high lysine fraction (NHL), and all hybrids vs a normal yellow dent corn (NC). Each diet consisted of a test corn (96.6%), a trace mineral (0.25%), vitamin (0.5%), limestone (0.85%), dical (1.25%), salt premix (0.3%), and an amino acid top dress. Chromic oxide (0.25%) was added as an indigestible marker. Diets were offered in two equal daily meals

for a period of seven days and the amino acid top dress was discontinued on d 5. Ileal digesta was collected for 12 hr on d 6 and d 7. Data for ileal starch, apparent protein, and true protein digestibilities are reported in the table. Ileal starch digestibility was similar between the following pre-planned comparisons: WX vs IWX, HO vs IHO, HL vs NHL, WX vs NC, HO vs NC (P > .05), but was different when HL was compared to NC (P > .05). All pre-planned comparisons between corn hybrids for apparent protein digestibility were similar (P > .05). All pre-planned comparisons were similar for true protein digestibility (P > .05), except HL vs NHL (P < .07). There was a significant correlation between ileal starch and apparent protein digestibility (r = .47; P < .001), and between apparent starch and true protein digestibility (r = .55; P < .001). In conclusion, growing pigs had a higher ileal starch digestibility for HL than NC. Also, true protein digestibility of NHL was higher when compared to HL.

Item	WX	IWX	HO	IHO	HL	NHL	NC	Pool SEM
Ileal Dig								
Starch, %	91.62	89.91	91.18	90.33	94.71 ^a	91.62	88.03 ^b	.996
App Dig								
Protein, %	61.36	56.43	63.59	62.27	61.60	71.30	62.44	2.65
True Dig								
Protein, %	75.89	71.92	78.93	78.60	76.17 ^c	87.97 ^d	75.95	2.78

Means in rows with different superscripts are different based on the pre-planned comparisons: WX vs IWX, HO vs IHO, HL vs NHL, WX vs NC, HO vs NC, HL vs NC. ^{a, b}(P > .05), ^{c, d}(P < .07)

Key Words: Ileal Starch Digestibility, Protein Digestibility, Corn Hybrid

202 Evaluation of high oil corn for grow-finish pigs. K. A. Bowers*, D. C. Kendall, and B. T. Richert, *Purdue University, West Lafayette, IN.*

One hundred and seventy-six pigs (PIC × York-Landrace; 88 barrows (B), 88 gilts (G); initial BW = 22 kg) were used to evaluate feeding high oil corn (HOC; 7.8% oil) and normal corn (NC; 3.9% oil) for grow-finish pigs. Average daily gain (ADG), average daily feed intake (ADFI), and gain to feed ratio (G:F) were determined at 14-day intervals. Backfat thickness was determined by ultrasound at 8 weeks and market weight (113 kg). Fat and loin depth, percent lean, carcass weight, and carcass premium were determined at a local slaughter facility. Pigs were blocked by sex, ancestry, and weight into 32 pens (5 or 6 pigs/pen) and fed one of four dietary treatments: 1) NC diet for 16 weeks (NC/NC); 2) NC diet for the first 8 weeks, period 1 (P1), and HOC diet for the second 8 weeks, period 2 (P2), (NC/HOC); 3) HOC diet during P1 and NC diet during P2 (HOC/NC); and 4) HOC diet for 16 weeks (HOC/HOC). HOC and NC were fed as an equal percentage of the diet in 4 split-sex phases (22-45 kg, 45-68 kg, 68-91 kg, and 91-113 kg). This project was conducted from February to May, 1999. Pigs fed HOC tended to have higher G:F (.407 vs. .392; P < .15) and ADG (.839 vs. .824 kg/d; P < .15) than pigs fed NC in P1. Pigs fed HOC had higher G:F (.294 vs. .272; P < .005), similar ADG (.915 vs. .901 kg/d; P < .50), and lower ADFI (3.12 vs. 3.32 kg/d; P < .025) than pigs fed NC in P2. Market weight backfat thickness were similar between all four dietary treatments (19.4 mm). Overall, pigs fed HOC/HOC had greater G:F (.349, .326, .334, .322; P < .08), but had similar ADG (.879, .873, .853, .861 kg/d; P < .41) and adjusted days of age to 113 kg (159.3, 160.4, 163.4, 162.2; P < .62) compared to HOC/NC, NC/HOC, and NC/NC, respectively. Barrows had greater ADG (P < .002) and ADFI (P < .002) in P1 and P2, and backfat thickness at market weight (21.7 vs. 17.2; P < .0001) than gilts. Gilts had greater loin depth (66.55 vs. 64.21 mm; P < .0001), percent lean (53.53 vs. 51.96 %; P < .0001), and carcass premium (\$.109/kg vs. \$.0463/kg; P < .0001) than barrows. Feeding high oil corn during the late grow-finish period (68-113 kg) improved feed efficiency by 7.5% and feeding high oil corn throughout all of the grow-finish period improved feed efficiency by 6.7%.

Key Words: Pigs, Grow-finish, High oil corn

203 Effects of conjugated linoleic acid and high oil corn on growth performance and pork quality in finishing pigs. J. C. Sparks*, J. E. Swan, S. T. Larsen, B. R. Wiegand, F. C. Parrish, and D. R. Zimmerman, *Iowa State University, Ames, IA.*

Forty-eight individually-penned barrows weighing 55 kg were fed diets containing normal corn (NC), NC + conjugated linoleic acid (CLA) (NC+CLA), high oil corn (HOC), HOC + CLA (HOC+CLA), NC

+ choice white grease (CWG) (NC+CWG) and NC + CWG + CLA (NC+CWG+CLA). CLA (60% CLA) was included at 1.25% and replaced soy oil. NC diets (low energy, LE) contained 3.3 Mcal ME/kg, whereas HOC and NC+CWG diets (high energy, HE) contained 3.5 Mcal ME/kg. Diets had equal lysine:ME ratios. Ultrasound measurements of backfat (BF) thickness and loin muscle area (LMA) were determined at BW of 55, 90 and 113 kg. Pigs were slaughtered at 113 kg. Pigs fed CLA had lower ADG ($P < .05$) for the first 28 d. However, by the end of the trial there was no effect ($P < .28$) of CLA. For the first 42 d, pigs fed HE had greater ($P < .05$) gain/feed (GF) than pigs fed LE. For the overall trial there was no difference in GF between pigs fed HOC and pigs fed LE. However, pigs fed NC+CWG did have a greater ($P < .05$) GF than pigs fed HOC diets. For the overall trial, pigs fed CLA had reduced ($P < .05$) GF. CLA improved GF of pigs fed HOC but it did not improve GF of pigs fed NC+CWG (interaction, $P < .01$). Pigs fed the LE diets had less ($P < .05$) 10th rib BF and greater LMA at 90 kg ($P < .05$) and just before slaughter ($P < .03$) than those fed HE diets resulting in a greater ($P < .001$) percent lean at 90 kg and slaughter. Carcasses of pigs fed LE diets had less ($P < .04$) BF at the last lumbar and 10th rib than those of pigs fed HE. Bellies from pigs fed CLA were firmer ($P < .001$) than bellies from those fed other treatments. Bellies of pigs fed the HOC diet were softer ($P < .03$) compared with bellies of pigs fed the NC diet, but the pigs fed HOC+CLA had bellies that were slightly firmer ($P < .13$) than those from pigs fed NC diet but less ($P < .03$) firm than those from pigs fed NC+CLA. In summary, CLA increased belly firmness, thus correcting the negative effect caused by feeding a high level of polyunsaturated fatty acids in HOC.

Key Words: pig, conjugated linoleic acid, high oil corn

204 Effect of reduction of dietary calcium and phosphorus and(or) phytase addition on the ileal digestibility of amino acids in pigs. S. L. Johnston*, L. L. Southern, and L. D. Bunting, *LSU Agricultural Center.*

Ileal digesta, collected from eight barrows (56.0kg) fitted with steered ileal-cecal cannulas, was analyzed to determine the effect of phytase addition and(or) reduction of dietary Ca and P on amino acid digestibility in corn-soybean meal diets for pigs. The experiment was a Latin rectangle with the following treatments: 1) corn-soybean meal diet (control) adequate in Ca and P (0.5% Ca, .19% aP), 2) Diet 1 with reduced Ca and P (0.4% Ca, .09% aP), 3) Diet 1 with 500 FTU of phytase, or 4) Diet 1 with reduced Ca and P and 500 FTU phytase. Pigs were fed twice daily at 0700 and 1900 h to a total daily intake of 2.6 times the maintenance requirement of 106 kcal of ME/kg of BW^{0.75}. Within each treatment period, ileal contents were collected, and contents for the individual pig combined for two 24-h periods. There was a 6-d period between each collection and after each diet change. Digesta were lyophilized, ground, and analyzed for amino acids and chromium concentration to allow for the determination of apparent ileal digestibility. When compared to the control diet, reducing the concentration of dietary Ca and P (Diet 2) increased ($P < .1$) amino acid digestibility in seven of the eight amino acids. Phytase addition to the Ca and P adequate diet (Diet 3) increased ($P < .1$) digestibility of four of the eight amino acids and tended ($P = .15$) to increase the digestibility of three others. Reducing dietary Ca and P along with phytase addition (Diet 4) increased ($P < .1$) digestibility of all eight amino acids compared with the control. In conclusion, Ca and P reduction, phytase addition, and the combination increased amino acid digestibility.

	Lys	Ile	Leu	Phe	His	Arg	Val	Thr	AVG
1. C-SBM	77.2	77.3	80.0	78.4	83.4	85.7	76.6	70.5	79.1
2. Low Ca-P	80.8	81.6	83.6	81.8	86.0	87.1	82.0	75.9	82.7
3. 1+500 FTU	79.9	81.0	83.2	81.1	85.3	86.9	79.0	74.4	81.8
4. 2+500 FTU	80.2	81.6	83.8	82.1	85.6	88.3	81.1	75.0	82.6
Diet 1 vs Diet 2	.04	.01	.02	.04	.06	NS ^a	.01	.01	.02
Diet 1 vs Diet 3	.11	.02	.03	.09	.14	NS	.15	.06	.07
Diet 1 vs Diet 4	.08	.01	.01	.03	.10	.03	.02	.03	.03
Pooled SEM	1.1	1.0	.9	1.1	.9	.8	1.1	1.3	1.0

^a $P = .20$

Key Words: Pigs, Phytase, Amino acids

205 Evaluation of nutrient release values for phytase in growing-finishing swine diets. M. D. Lindemann, A. L. de Souza*, H. J. Monegue, and G. L. Cromwell, *University of Kentucky, Lexington.*

Crossbred pigs ($n = 216$, 23 kg BW) were used to evaluate nutrient release formulation matrix values for varying levels of phytase in corn-soy diets. Pigs were allotted (four replicates of six pigs/pen) to nine treatments. Treatment (trt) 1 was a positive control diet formulated for the given weight range; trt 2-5 were the control diet with 200, 300, 400, or 500 FTU of phytase/kg, respectively, with corn, soy, fat, and dicalcium phosphate adjustments made to reflect the planned contribution of the nutrients released by the phytase; and trt 6-9 were as trt 2-5 but without phytase addition. Diets were reformulated at pig weights of 41, 63, and 86 kg. Lysine, Ca, P, and P_a levels for the control diet in the four phases were .95, .70, .62, .32; .85, .62, .59, .29; .75, .60, .54, .25; and .60, .56, .48, .21%, respectively. Phytase at 500 FTU/kg inclusion rate was assumed to release .01% lysine, .12% Ca and P_a, and 10 kcal ME/kg. At 110 kg mean BW, pigs were scanned with real-time ultrasound. At termination, 3rd and 4th metacarpals (MC) were obtained for breaking strength determination. Total trial ADG and feed:gains were: 835, 844, 844, 840, 835, 868, 836, 831, 819 g; 2.72, 2.72, 2.79, 2.79, 2.74, 2.73, 2.70, 2.80, respectively. There were no linear or quadratic effects ($P = .10$) associated with lowering nutrients with (trts 1-5) or without (trts 1, 6-9) phytase additions. Backfat depth and loin muscle area (LMA) adjusted to 104 kg were: 19.7, 19.5, 20.5, 20.5, 21.2, 19.4, 19.9, 20.7, 21.2 mm; 39.4, 38.8, 38.8, 38.6, 38.2, 38.9, 39.1, 39.2, 39.1 cm², respectively. Linear trends were observed ($P < .10$) for increased backfat with or without phytase with no effect ($P = .10$) on LMA. MC strength was 206, 200, 196, 204, 199, 202, 181, 180, 160 kg (linear [$P < .001$] in diets without phytase). Ca and P release values associated with these levels of phytase seem to be appropriate.

Key Words: Pigs, Phytase, Performance

206 Bioavailability of phosphorus in low-oligosaccharide, low-phytate soybean meal for pigs. G.L. Cromwell*¹, S.L. Traylor¹, M.D. Lindemann¹, T.E. Sauber², and D.W. Rice², ¹University of Kentucky, Lexington, ²Optimum Quality Grains, Des Moines, IA.

The bioavailability of P in soybean meal (SBM) from low-oligosaccharide, low-phytate (LP) soybeans and near-isogenic normal (N) soybeans was determined in growing pigs. The LP-SBM and N-SBM analyzed .77 and .70% total P, .22 and .48% phytate P, .55 and .22% non-phytate P, and 1.13 and 5.30% oligosaccharides. Individually-penned pigs ($n = 35$, 13.5 kg BW, 5/treatment) were fed 7 diets for 38 d. A low P, fortified basal diet (1.05% lysine, .70% Ca, .30% P) consisted mainly of dextrose, starch, and non-experimental (NE) SBM. All of the P in the basal originated from the NE-SBM. Diets consisted of the basal (Diet 1) or the basal with .08 or .16% added P from monosodium phosphate (MSP, Diets 2 and 3), or the same levels of added P from N-SBM (Diets 4 and 5) or LP-SBM (Diets 6 and 7). The N- and LP-SBM were substituted for dextrose-starch. Gain and feed:gain were: 567, 772, 852, 635, 622, 716, 734 g/d; 2.28, 1.92, 1.90, 1.89, 1.78, 1.91, 1.71, respectively. Apparent digestibility of P (using Cr₂O₃) was 17, 35, 39, 23, 19, 24, and 28%. At the end, all pigs were killed and the 3rd and 4th metacarpals and metatarsals (MM) and femurs were removed. Breaking strength of the MM (18.7, 30.0, 44.3, 20.0, 20.2, 24.6, 24.7 kg) and femurs (67, 165, 240, 78, 91, 110, 138 kg) and MM ash (1.40, 2.00, 2.58, 1.63, 1.61, 1.81, 1.95 g; 44.3, 49.3, 51.4, 44.4, 44.4, 46.7, 49.0%) increased linearly with increasing P from MSP ($P < .01$) or LP-SBM ($P < .03$). For growth and bone traits, MSP was superior ($P < .01$) to SBM, and LP-SBM was superior ($P < .01$) to N-SBM. Bone strength and ash weight were regressed on grams of added P consumed for each P source with the basal included in the regressions, and slopes were determined for each P source. Based on slope-ratios, the mean relative bioavailability of P (assuming MSP = 100%) was 19% for N-SBM and 49% for LP-SBM. These results indicate that the P in LP-SBM is two to three times as bioavailable as the P in N-SBM for growing pigs.

Key Words: Pigs, Soybean Meal, Phytate

207 Relative phosphorus availability and retention of low-phytate/low-oligosaccharide soybean meals for growing pigs and chicks. J. D. Spencer^{*1}, G. L. Allee¹, J. W. Frank¹, and T.E. Sauber², ¹University of Missouri-Columbia, ²Optimum Quality Grains, LLC.

Two types of soybean meal containing low levels of phytate P and oligosaccharides (LPL01, .65% P; LPL02, .57% P), and a normal soybean meal equivalent (N, .63% P) were fed in three trials to determine relative phosphorus bioavailability (RBV) and retention for growing pigs and broiler chicks. Exp. 1 utilized 50 pigs (11.3 kg) individually penned with 10 treatments. A corn starch/dextrose/commercial SBM basal diet (.6 Ca, .2% P) was used. Treatments consisted of the basal diet plus .05, .10, and .15% added P from LPL02, N, or monosodium phosphate (MSP). Pigs consumed diets for 28 d, then were killed to harvest the 4th metacarpal for measurement of bone breaking load (BL). The BL was regressed on total P intake added by the test source, and the P RBV (relative to MSP) was determined by slope ratio. Exp. 2 consisted of a slope ratio study with 325 broiler chicks (7 d age) and 13 treatments. There were 5 replications/trt. Treatments consisted of a basal diet (1.0 Ca, .37% P) plus .05, .10, and .15% added P from LPL01, LPL02, N, or MSP. Birds consumed diets for 14 d, then were killed for determination of tibia ash. The RBV of P in LPL02 and N for pigs (Exp. 1) was 69 and 27%, respectively. For broilers in Exp. 2, P RBV was found to be 81, 80 and 34% for LPL01, LPL02, and N, respectively. Exp. 3 used 18 pigs (25 kg) individually penned for total collection of feces and urine (5 d adjustment, 5 d collection). Diets consisted of a corn starch/dextrose mixture (.6% Ca) with 30% added SBM from LPL01, LPL02, or N sources to a CP level of 16.3%. Pigs fed LPLO SBM retained more P (58 and 62% for LPL01 and LPL02, respectively) than those fed N SBM (31%) ($P \leq .01$). We conclude that the P RBV in LPL01 and LPL02 soybean meal is considerably higher than N, and that P excretion is decreased with the utilization of these low-phytate/low-oligosaccharide soybean meals.

Key Words: Phosphorus, Availability, Phytic acid

208 Effects of low-phytate corn and low-oligosaccharide, low-phytate soybean meal in diets on performance, bone traits and phosphorus excretion by growing pigs. G.L. Cromwell^{*1}, S.L. Traylor¹, L.A. White¹, E.G. Xavier¹, M.D. Lindemann¹, T.E. Sauber², and D.W. Rice², ¹University of Kentucky, Lexington, ²Optimum Quality Grains, Des Moines, IA.

Diets containing low-phytate corn (LP-corn) or near-isogenic normal corn (N-corn) and low-oligosaccharide, low-phytate soybean meal (LP-SBM) or normal soybean meal (N-SBM) from near-isogenic soybeans were evaluated. The LP-corn, N-corn, LP-SBM, and N-SBM contained .28, .25, .77, and .70% total P; .10, .20, .22, and .48% phytate P; and .18, .05, .55, and .22% non-phytate P; with estimated P bioavailabilities of 75, 20, 50, and 20%, respectively. The LP- and N-SBM contained 1.13 and 5.3% oligosaccharides. Individually-penned pigs (8/treatment) were fed nine corn-SBM diets (.95% lysine, .65% Ca) from 22 to 49 kg (36 d). Diets 1-3 were N-corn and N-SBM with .20, .10, and .00% added P from dicalcium phosphate. Diets 4-6 were N-corn and LP-SBM, and Diets 7-9 were LP-corn and LP-SBM with the same P additions as Diets 1-3. Diets 3, 6, and 9 (no added P) contained .35, .37, and .39% P and .07, .13, and .24% bioavailable P, respectively. At termination, metatarsals and metacarpals (MM) and femurs were obtained from all pigs. Rate and efficiency of gain and MM and femur strength were linearly ($P < .01$) reduced by lowering P in diets containing N-corn and N-SBM (800, 753, 628 g/d; 2.22, 2.30, 2.62; 83.4, 60.7, 42.1 kg; 292, 219, 157 kg). Reducing P affected performance and bone strength (quadratic, $P < .05$) to a lesser extent when LP-SBM was fed, especially when combined with LP-corn ($P > .20$) (785, 769, 729, 806, 797, 790 g/d; 2.16, 2.26, 2.30, 2.24, 2.16, 2.19; 76.0, 74.7, 58.0, 74.0, 83.5, 79.5 kg; 268, 266, 187, 313, 305, 292 kg for Diets 4-9). Apparent digestibility of P (using Cr₂O₃) for Diets 1-9 was 29, 20, 9, 38, 31, 29, 52, 53, 50% ($P < .01$). Fecal P excretion was influenced ($P < .01$) by type of corn and SBM fed and P level (7.0, 6.2, 5.3, 6.0, 5.6, 4.3, 5.1, 4.0, 3.3 g/d). The results suggest that growing pigs fed LP-corn and LP-SBM require less supplemental P and excrete up to 55% less fecal P than pigs fed typical corn-SBM diets.

Key Words: Pigs, Soybean Meal, Phytate

209 Comparison of apparent nutrient digestibility values of normal and low-phytate/low-oligosaccharide soybean meals in growing pigs. J. W. Frank^{*1}, C. D. Cooper¹, G. L. Allee¹, and T. E. Sauber², ¹University of Missouri, Columbia, MO, ²Optimum Quality Grains, LLC, Urbandale, IA.

Eight crossbred barrows (initial BW = 68 kg) were surgically fitted with ileal cannulas to determine apparent nutrient digestibility of four soybean meal (SBM) samples. Pigs were assigned their respective diets and arranged in a 4 × 4 Latin square. Semi-purified diets contained a commercial SBM (C, total P .64%), low-phytate/low-oligosaccharide SBM type 1 (LPLO1, total P .65%), low-phytate/low-oligosaccharide SBM type 2 (LPLO2, total P .57%), or normal SBM (N, a near equivalent of the LPLO soybean meals, total P .63%). Sample C was obtained from a commercial source. LPLO1, LPLO2, and N were processed in a pilot plant. For LPLO1, LPLO2, and N soybean KOH solubility was 65.01, 55.01, 63.43% and trypsin inhibitor activity was 1900, 3420 and 3590 TU+IU/g, respectively. Experimental diets were given twice daily (0600 and 1800 hr) at a rate of .09 × BW^{.75} for a five day adjustment period, followed by two days of twelve-hourly collections of ileal digesta. Phosphorus digestibility values were greater in LPLO1 (55%) and LPLO2 (58%) compared to C (43%) and N (45.5%; $P < .05$). Gross energy digestibility was greatest for LPLO1 (81.1%) compared to LPLO2 (79.2%), C (78.3%), and N (77.7%; $P < .05$). Total indispensable amino acid digestibility was greater in LPLO1 (85.0%) compared to C (81.9%) and LPLO2 (80.7%; $P < .05$), with N (82.1%) being intermediate. Lysine digestibility was greater in C (83.2%) and LPLO1 (82.9%) compared to N (78.6%) and LPLO2 (76.0%; $P < .05$). Methionine digestibility was greater in LPLO1 (88.2%) compared to N (85.6%) and LPLO2 (84.2%; $P < .05$), and similar to C (86.2%). Threonine digestibility was greater in LPLO1 (77.7%) compared to C (73.8%) and LPLO2 (72.9%; $P < .05$), but similar to N (74.0%). Total dispensable as well as total amino acid digestibility in LPLO1 was greater than LPLO2 ($P < .05$). LPLO soybean meals have greater P digestibility than C and N soybean meals. Nutrient digestibility was greatest for LPLO1 compared to the other soybean meals.

Key Words: Pigs, Digestibility, Ileal

210 Effect of high available phosphorus corn and phytase on phytate phosphorus utilization and growth performance of young pigs. J. S. Sands^{*1}, O. Adeola¹, D. Ragland¹, C. A. Baxter¹, B. C. Joern¹, and T. E. Sauber², ¹Purdue University, West Lafayette, IN 47907, ²Optimum Quality Grains, Urbandale, IA 50322.

Reducing the amount of phytate in corn represents an alternative approach to improving phosphorus (P) utilization that circumvents some of the inherent challenges in adding enzymes to feed. Two experiments (exp.) were conducted to compare P utilization in young pigs fed diets formulated with either, high available phosphorus (HAP) or regular corn (REG) and phytase at 0 or 600 U/ kg in a 2 X 2 factorial arrangement. Diets 1 and 2 contained HAP corn with 0 and 600 U/ kg of phytase, respectively. Diets 3 and 4 contained REG corn with 0 and 600 U/ kg of phytase, respectively. In exp. 1, a total of 24 crossbred barrows, averaging 14.0 kg were used to evaluate nutrient digestibility. Energy digestibility for diet 4 was higher ($P < .05$) than diet 2. Nitrogen (N) intake from diets 1 and 2 were greater ($P < .05$) than diets 3 and 4, but percent digestibility of N was not different ($P > .05$); however, N retention, was higher in pigs consuming diet 2 compared to diet 3. Pigs receiving diet 2 had improved ($P < .05$) calcium retention when compared to those on diet 3. Intake of P was lower ($P < .01$) for pigs consuming diet 2 than diet 1, 3, or 4. The retention and digestibility of P for diet 3 was lower ($P < .01$) than diet 1, 2 or 4. In exp. 2, 48 crossbred pigs, (barrow: gilt 1:1) averaging 9.25 kg were used to evaluate growth performance. The consumption of diet 1, 2 or 4 led to higher ($P < .05$) final body weights and rates of gain than diet 3. Pigs receiving diet 3 also had lower ($P < .05$) feed efficiency compared to those on diets 2 and 4. These findings are consistent with previous reports on the ability of phytase to improve the utilization of phytate P and growth in pigs. Further, the current findings provide evidence that HAP corn also, effectively improves P utilization.

Key Words: Phytase, HAP Corn, Pigs

211 Nutrient retention and growth performance of pigs fed diets formulated with low-phytate corn and/or low-phytate/low-oligosaccharide soybean meal. J. D. Spencer^{*1}, G.L. Allee¹, J.W. Frank¹, and T.E. Sauber², ¹University of Missouri-Columbia, ²Optimum Quality Grains, LLC.

Low-phytate corn (LP, .27% P) containing the *lpa 1-1* allele and a low-phytate/low-oligosaccharide SBM (LPLO, .57% P) were fed to growing pigs in two studies to determine effects on nutrient retention and growth performance when diets were balanced to an equal available P (AP) content. In Exp. 1, 20 barrows (12.3 kg) were individually penned for total collection of feces and urine (5 d adjustment, 5 d collection) in a 2 x 2 factorial arrangement of treatments with 2 corn types (Normal (N), .23% P and LP) and 2 types of SBM (N, .63% P, and LPLO). Diets (1.1% lysine, .6% Ca, .23% AP) were formulated using previously determined AP estimates of .03 and .17% for N and LP corn, and .17 and .40% AP for N and LPLO SBM, respectively. Diets were adequate in all nutrients. The diet containing both LP corn and LPLO SBM was the only diet that did not require supplemental inorganic P. There was no difference in energy digestibility or N retention. Pigs consuming diets formulated with LP corn and LPLO SBM had improved P retention and less total P excreted (main effects of corn and SBM type, $P \leq .01$). Pigs fed diets formulated with both LP corn and LPLO SBM excreted 56% less P than pigs fed N corn/N SBM. Exp. 2 used 28 barrows (12.2 kg) individually penned and fed the same dietary treatments as Exp. 1 for 28 d. Pigs were then killed to collect the 3rd and 4th metacarpals for determination of average bone breaking load (BL). There was no difference between treatments for ADG and feed efficiency. Bone BL was lower for pigs fed diets containing LP corn and N SBM (main effect of SBM type, $P \leq .05$), but could be due to the fact that pigs fed this diet had a slightly lower ADFI. These studies support the previously determined AP estimates of LP corn and LPLO SBM. Furthermore, these studies display the dramatic reduction in P excretion that is possible when diets are formulated with low-phytate corn and low-phytate/low-oligosaccharide soybean meal.

Key Words: Pigs, Phosphorus, Phytic acid

212 The influence of fiber-degrading enzymes and steeping on the apparent ileal digestibilities of amino acids in growing pigs fed a semipurified corn starch soybean meal-based diet. D.M. Albin^{*}, M.R. Smiricky, J.E. Wubben, and V.M. Gabert, University of Illinois, Urbana, IL.

Eight PIC barrows (average initial BW = 69.9 kg) were surgically fitted with a simple-T cannula at the distal ileum to evaluate the influence of fiber-degrading enzymes (Cellulase, 30,080 units/kg diet and Hemicellulase, 531 units/kg diet, Sigma Chemical Co., St. Louis, MO) and steeping (soaking meals in water for 12 h prior to feeding) on ileal amino acid digestibilities. Water was added to each steeped meal on a 1:1 weight basis. The four treatments used were a corn starch-soybean meal based control diet; control diet plus cellulase (.32% as-fed) and hemicellulase (2.95% as-fed) added at the expense of corn starch; control diet plus steeping; and control diet with added enzymes plus steeping. The diets were formulated to contain 17% CP and .5% chromic oxide. The pigs were fed 1.76 kg/d and 1.84 kg/d in the first and second periods, respectively, and were fed at 0800 and 2000 h. Water was available *ad libitum* from a low-pressure drinking nipple. The duration of the experiment was two seven-day periods. Each period was divided into a 5 d adaptation period and a 2 d collection period. Ileal digesta were collected for 12 h intervals over two days. Amino acids were measured using pre-column derivatization with phenyl isothiocyanate and HPLC. Methionine, cysteine and tryptophan were not determined. Fiber-degrading enzymes and/or steeping did not affect ($P > .05$) the apparent ileal digestibility of dry matter, organic matter, crude protein, and amino acids. Digestibility tended to decrease from the first period to the second period, but was only lower ($P < .05$) for threonine, alanine, arginine and isoleucine. These results suggest that feeding two fiber-degrading enzymes at these levels and/or steeping did not affect apparent ileal digestibilities of amino acids in growing pigs fed a corn starch-soybean meal diet.

Key Words: Pigs, Amino acid digestibility, Enzymes

213 The influence of feed enzymes and feed steeping on total tract digestibility and fecal output in growing pigs fed a corn-soybean meal diet. M. R. Smiricky^{*}, D. M. Albin, J. E. Wubben, and V. M. Gabert, University of Illinois, Urbana, IL.

Eight PIC barrows (average initial BW = 43 kg) were randomly assigned to two 4 x 4 Latin squares to evaluate the influence of six enzymes and feed steeping (soaking meals for 12 h prior to feeding) on nutrient digestibility and total fecal output. The individual enzyme activities in the diets containing enzymes were Cellulase, 3400 Units/kg diet; hemicellulase, Hemicell D, 165,000 Units/kg diet; amylase, Avizyme 1500, 2128 Units/kg diet; protease, Avizyme 1500, 21,280 Units/kg diet; xylanase, Avizyme 1500, 1596 Units/kg diet; and alpha-galactosidase, Alpha-Gal 600L, 1800 Units/kg diet. Water for feed steeping was added in a 1.45:1 ratio on a weight basis. The two squares used two protein levels (14 and 18%). The four treatments evaluated in each square were a corn-soybean meal based control diet; control diet steeped; control diet plus cellulase (.068% as-fed), hemicellulase (.1% as-fed), Avizyme 1500 containing amylase, protease, and xylanase (.532% as-fed), and alpha-galactosidase (.3% as-fed) added at the expense of corn starch; and control diet plus added enzymes steeped. The pigs were fed 1.8, 1.92, 2.0, 2.06 kg/d respectively during periods 1-4 and were fed at 0800 and 2000 h. Water was available *ad libitum*. The experiment comprised four nine-day periods with 4 d of adaptation and 5 d of fecal collection. Dry matter, protein, and organic matter digestibilities were determined using chromic oxide (.3% as-fed) as an indigestible marker. Feed enzymes and/or feed steeping did not affect ($P > .05$) the apparent digestibility of dry matter, crude protein, or organic matter. Total fecal output was not affected ($P > .05$) by the addition of enzymes or feed steeping, but increased ($P < .05$) with increasing dietary protein level. These results indicate that feeding these six feed enzymes in conjunction with or in the absence of feed steeping did not affect total fecal output or the digestibility parameters measured in growing pigs fed a corn-soybean meal diet.

Key Words: Pigs, Enzymes, Digestibility

214 Effects of Hemicell[®] addition to corn-soybean meal diets on growth performance, carcass traits, and apparent nutrient digestibility of finishing pigs. L.A. Pettey^{*}, S.D. Carter, B.W. Senne, and J.A. Shriver, Oklahoma State University, Stillwater.

Two experiments were conducted to evaluate the effects of Hemicell[®] (B-mannanase; Chem-Gen Corp., Gaithersburg, MD) addition to a corn-SBM diet on growth performance, carcass traits, and nutrient digestibility of finishing pigs. In Exp. 1, 60 pigs (22.5 kg BW) were allotted by BW, sex, and litter to three dietary treatments (five pens/trt of four pigs/pen). Diets were: (1) simple corn-soybean meal-based control, (2) as 1 + soybean oil (SBO) to increase ME by 100 kcal/kg, and (3) as 1 + Hemicell[®] (.05%). Pigs were fed in three dietary phases (23-53, 53-82, 82-109 kg BW with .95, .80, and .65% Lys, respectively). ADG, ADFI and G:F for the three diets were: .843, .829, .873 kg; 2.50, 2.32, 2.48 kg; and .337, .358, .351, respectively. Hemicell[®] increased ($P < .02$) ADG compared with pigs fed the control or SBO diets. SBO improved ($P < .06$) G:F compared with pigs fed the control diet. Also, pigs fed diets with Hemicell[®] had similar G:F compared with pigs fed diets with SBO. At 110 kg BW, pigs were slaughtered and carcass measurements collected. There were no differences in LMA; however, pigs fed diets with SBO or Hemicell[®] tended to have less 10th rib fat than pigs fed the control diet. On a fat-free basis, lean gain for the three diets were: .322, .327, and .340 kg/d. Pigs fed diets with Hemicell[®] had a higher ($P < .03$) lean gain and more ($P < .03$) carcass lean tissue than pigs fed the control or SBO diet. In Exp. 2, 12 barrows (97 kg BW) were allotted to the three dietary treatments as in Exp. 1. Pigs were penned individually and fed *ad libitum* for 14 d. From d 10-14, Cr₂O₃ was used to determine apparent total tract digestibility. Digestible energy values for the three treatments were: 85.9, 86.9, and 86.5%. Addition of Hemicell[®] had no effect ($P > .10$) on energy, nitrogen, phosphorus, or dry matter digestibility. These results suggest that Hemicell[®] may improve growth performance and lean gain in finishing pigs, but has minimal effects on nutrient digestibility.

Key Words: Enzyme, Pigs, Utilization

216 Effectiveness of intravaginal progesterone inserts and FSH to induce synchronized estrus and increase lambing rate in anestrus ewes. M. Knights*, T. Hoehn, P.E. Lewis, and E.K. Inskeep, *West Virginia University Morgantown WV USA.*

Treatment of anestrus ewes with progestogens induces estrus, but is associated with lower, more variable conception rates and lower ovulation rates than in the breeding season. Objectives of this study were to evaluate, in anestrus ewes (progesterone < 0.6 ng/ml in serum), effectiveness of: 1) a new progesterone releasing insert (polycapralactone, 0.82g progesterone) to induce estrus, 2) a single injection of FSH (Folltropin; 55 mg NIH-FSH-P1 equivalent) in propylene glycol, one day (24 h) before insert removal (IR; day 0), to increase lambing rate and a short-term (5-day) progesterone treatment to induce estrus. A total of 295 predominantly crossbred ewes (mainly Suffolk and Dorset) in 4 replicates were studied. Ewes were assigned at random to 4 treatment groups, control (C), n = 73; 12 d progesterone (P12), n = 73; 12 d progesterone plus FSH (P12F), n = 71; and 5 d progesterone plus FSH (P5F), n = 77. Blood samples were taken on d -12, -10, -8, -6, -4, -2 and 0 in 20 ewes/replicate. Intact rams were joined at IR (d 0) and ewes were observed for estrus every 12 h. Mean progesterone during treatment (0.8, .1, 0.7, .1 and 0.9, .1 ng/ml for P12, P12F and P5F, respectively) was elevated compared to C (0.2, .1). Percentage of ewes detected in estrus within 5 d of IR (12, 77, 66 and 79 % for C, P12, P12F and P5F, respectively) was higher in treated than in control groups (P < .001) and in P5F than in P12F (P < .05). Mean time from IR to estrus (41h) did not differ among treated groups. Ewes lambing to one (0, 45, 38 and 42 %) and two (41, 66, 64 and 63% for C, P12, P12F and P5F, respectively) services were higher (P < .001) in progesterone-treated than in control ewes. FSH did not increase lambing rate for ewes lambing to one (1.6, .1, 1.9, .1, and 1.8, .1 for P12, P12F and P5F, respectively) or both services (1.5, .1, 1.5, .1, 1.6, .1, 1.8, .1 for C, P12, P12F and P5F, respectively). The new inserts did not deliver sufficient progesterone to mimic cyclic concentrations however, inserts in combination with ram introduction at removal induced synchronized estrus and ovulation. A 5-day progesterone treatment was as effective as a 12-d treatment in inducing two fertile estrus in anestrus ewes.

Key Words: Ewe, Anestrus, Progesterone-insert

217 Assessment of flow cytometry and methods using SYBR-14/propidium iodide fluorochrome stain with extended, chilled semen from range-type beef bulls. A. A. Moravec*¹, G. P. Rupp², M. J. Wilkerson¹, and P. J. Chenoweth¹, ¹College of Veterinary Medicine, Kansas State University, Manhattan, KS, ²Great Plains Veterinary Education Center, University of Nebraska, Clay Center, NE.

A total of 56, sexually mature beef bulls at the USDA, Meat Animal Research Center (Clay Center, NE), was subjected to routine breeding soundness evaluation, including assessment of physical traits, collection of semen via electro-ejaculation and evaluation of seminal traits. In addition, sperm viability was assessed using SYBR14/PI fluorochromes with flow cytometry (SP-FC) in order to compare results with traditional measures and to evaluate the utility of such procedures using non-frozen semen from range-type beef bulls. Semen samples were extended (E) in an egg-yolk-TRIS extender, chilled (C), transported to the laboratory, stained with fluorochromes (SP) and evaluated between 4 and 7 hours post collection. Test repeatability was assessed with split ejaculates (11-24 replicates) on 4 bulls. In addition, comparison was made of 4 handling combinations as follows; 1) E,C,SP with FC within 4-7h of collection, 2) E,C,SP and stored at 36 ° C for 12 hours prior to FC, 3) E,C,SP and stored at 5 ° C overnight prior to FC, and 4) E,C, held overnight at 5 ° C before SP and FC. No physical measures of bulls were associated with SP-FC values. Sperm viability estimations were generally higher (22.90%) for SP-FC than for microscopic evaluation of nigrosin-eosin stained sperm. SP-FC sperm viability was associated with the following; initial sperm motility (M1; r=0.49; P<0.001), motility immediately prior to SP-FC (M2; r=0.33; P<0.02), percent normal sperm (N; r= 0.29; P<0.04) and with percent intact acrosomes (PIA; r=0.34; P<0.02). SP-FC non-viability was associated with the following; M1 (r=-0.38; P<0.05) and PIA (r=-0.42; P<0.003). SP-FC dual-stained sperm were associated with N (r=-0.038; P<0.05). Repeatability of procedure 1 was considered to be acceptable (SE 2.13%),

despite sporadic abnormal readings. Semen samples processed via procedure 4 were obtained results closest to procedure 1. Field samples may be satisfactorily assessed using FC methodology, although cost and logistics may be prohibitive.

Key Words: Semen Evaluation, Sperm Viability, SYBR-14/Propidium Iodide Stain

218 The effects of bull exposure and lasalocid on pubescent estrus and timed AI conception rates in cross-bred beef heifers. J. A. Small*¹, R. P. Del Vecchio², W. P. McCaughey¹, D. R. Ward¹, and W. D. Sutherland¹, ¹Agriculture & Agri-Food Canada, Brandon, ²Louisiana State University, Baton Rouge.

Establishment of pregnancy by 15 months of age is essential for heifers to calve as 2-year olds early in the calving season. Heifers, born in either the winter (January-February n=80) or spring (March-April n=144), were assigned at fall weaning (late September) to one of two winter housing environments (BE and NE; with or without sterilized bulls), and one of two diets (LA and NL; with or without lasalocid (200 mg/hd/d) within housing environment. The heifers were offered a mixed ration consisting of corn silage, barley greenfeed and a premix (wheat distillers grain with or without Bovatec[®]) such that 10% was refused daily. Treatments and twice daily observations of estrus began on November 5th. Artificial insemination (AI) timed at 66 h after the second of two doses of PG, given 10 d apart, (Lutalyse[®]) was used to breed heifers for the first time at 14±0.04 months of age. Concentrations of P4 in blood plasma were used to confirm estrus/ovulation and to determine PG response rate. Real-time ultrasonography (Aloka 560, 5.6 MHz probe) was used to determine timed AI conception rate (CR). For heifers born in winter, the average daily rate of body weight gain (ADG) was lower (P<0.05) for LA than NL (0.66 and 0.73, 0.02 kg), but the proportions that were pubescent as yearlings (69 and 57%), responded to PG (85 and 55%), and conceived to timed AI (56 and 32%) were higher (P<0.05) for BE than NE, and CR for PG respondents (76 and 52%) was higher (P<0.05) for LA than NL. For heifers born in spring, ADG was higher (P<0.05) for LA than NL (0.81 and 0.77, 0.02 kg), but pubescent yearling rate (64 and 76%), PG response rate (65 and 84%), CR (26 and 57%) and CR for PG respondents (35 and 74%) were lower (P<0.05) for BE than NE. Pregnancy establishment was advanced when BE was introduced to pubescent heifers and delayed when BE was introduced to prepubescent heifers.

Key Words: Social environment, Ionophore, Heifer development

219 Use of GnRH to increase the precision of estrus and augment timed insemination in heifers treated with melengestrol acetate and PGF_{2α}. J.E. Huston*¹, S.K. Johnson², V.L. Bogacz¹, D.E. Grum¹, and M.L. Day¹, ¹The Ohio State University, ²Kansas State University.

The potential of adding GnRH to an MGA-PGF_{2α} based synchrony system to increase the precision of synchronized estrus and augment timed AI was investigated. Yearling heifers from four herds (n=709) were fed melengestrol acetate (MGA; .5mg/head) daily for 14 days (d -32 to d -19 of the experiment). Nineteen d after the last feeding of MGA, all heifers were administered 25mg of PGF_{2α} (d 0). Heifers receiving no further treatment served as the untreated controls (Control; n=253) and were AI 12h after detection of estrus during the synchrony period (d 0 to d 7). In the second treatment, heifers received an injection of GnRH (100µg) on d -7 (GnRH, n=260) and were AI based upon detection of estrus during the synchrony period. Heifers in the third treatment received GnRH on d -7 and d 2 (2XGnRH, n=196) and were AI coincident with the GnRH on d 2 (timed AI). Heifers in the 2XGnRH treatment that were detected in estrus before d 1.5 were not inseminated on d 2. Proportion of heifers exhibiting estrus during the synchrony period (86.1 and 90.7%) and the average day of insemination during the synchrony period (d 3.0, .09 and 2.8, .08) did not differ between the Control and GnRH treatments, respectively. Conception rate (during the synchrony period) for Control (74.9%) and GnRH (70.0%) treatments did not differ and were greater than (P < .05) conception rate (timed AI) in the 2XGnRH treatment (46.1%). Similarly, pregnancy rate during the synchrony period did not differ for Control and GnRH treatments (63.6

and 61.6% respectively) but were greater than ($P < .05$) the 2XGnRH treatment (41.8%). Pregnancy rate for the entire breeding season did not differ among treatments. In comparison to a standard MGA-PGF₂ α synchronization system, addition of GnRH on d -7 did not increase the precision of estrus. Addition of 2 injections of GnRH (d -7 and d 2) facilitated timed AI, however, pregnancy rate for timed AI was lower than pregnancy rate for AI 12h after detection of estrus during the synchrony period.

Key Words: Melengestrol, GnRH, Heifer

221 Effect of timing of feeding MGA in conjunction with a GnRH-PGF₂ α synchronization protocol on reproductive performance in postpartum cows. V.L. Bogacz*, J.E. Huston, D.E. Grum, and M.L. Day, *The Ohio State University*.

The objective of this study was to determine the potential benefits of feeding melengestrol acetate (MGA) at varying times during a GnRH-PGF₂ α -GnRH synchronization protocol. A total of 220 postpartum beef cows from two locations were assigned to one of three treatment groups based on d postpartum and age. The control treatment (GnRH; n=76) included an injection of 100 μ g GnRH on d -9, 25mg of PGF₂ α on d -2, and a second dose of GnRH given in conjunction with timed AI on d 0 (d 0 = d of second GnRH injection and timed AI). The remaining cows received the control treatment described above and in addition were fed MGA daily (.5mg/head) for 7 d from d 0 to d 6 (GnRH-MGA; n=70) or from d -8 to d -2 (MGA-GnRH; n=74). Blood samples were collected on d -18, -9, -2 and 11 and analyzed for plasma concentrations of progesterone (P₄) to determine ovarian status (cyclic vs. anestrous) preceding the first GnRH injection and the proportion of cows with luteal concentrations of P₄ at the time of PGF₂ α injection (d -2) and 11 days after the second injection of GnRH (d 11). The proportion of cyclic (n=149) and anestrous (n=96) animals did not differ among treatments. Luteal P₄ concentrations were present on d -2 in 38% (GnRH), 44% (GnRH-MGA) and 61% (MGA-GnRH) of cows ($P > .1$) that were anestrous on d -9, and were present in 84% of all cows on d 11. The percentage of cows that conceived to the timed AI were 53%, 49% and 42% for the GnRH, GnRH-MGA, and MGA-GnRH groups respectively and did not differ ($P > .1$). Mean day of conception (13.5 \pm 1.3) and the percentage of cows pregnant at the end of the breeding season (90.0%) did not differ among treatments ($P > .1$). Reproductive performance was not enhanced by feeding MGA either before or during a timed insemination protocol using GnRH and PGF₂ α . Further investigation is needed to determine if the addition of MGA to this synchronization protocol will enhance reproductive performance.

Key Words: MGA, GnRH, Postpartum

222 Effects of Estradiol-17 β on Serum and Anterior Pituitary (AP) Concentrations of IGF-I and IGF Binding Proteins (IGFBPs) in Barrows. L.A. Rempel*, T.M. Clark, and J.A. Clapper, *South Dakota State University, Brookings, SD*.

Estradiol-17 β (E2) has been shown to affect the IGF system in many different species and in several different tissues including the AP. To determine if E2 alters serum and AP concentrations of IGF-I and relative amounts of serum and AP IGFBPs, and AP concentrations of LH in pigs, 20 crossbred barrows (150 6 d, 103 8 kg) were stratified by litter to one of four treatment groups (n=5) on d 0. Treatment groups were; no E2 implants (C), two E2 implants (2), three E2 implants (3), and four E2 implants (4). Implants contained 25.7 mg E2 and were placed at the base of the ear. Barrows were penned separately and had ad libitum access to feed and water. Blood samples were collected by jugular venipuncture on d 0, 7, 14, 21, and 28. Pigs were killed on d 35 when blood samples and APs were collected. Serum concentrations of IGF-I, E2 and AP concentrations of IGF-I and LH were determined by RIA. Relative amounts of serum and AP IGFBPs were determined by Western ligand blot analysis. Serum concentrations of E2 were increased ($P < .05$) in groups 2, 3, and 4 vs C, but no difference ($P > .05$) was detected in serum concentrations of E2 among groups 2, 3, and 4. Serum and AP concentrations of IGF-I were increased ($P < .05$) in groups 2, 3, and 4 compared to group C. Western ligand blot analysis identified 46 and 41 kDa forms of IGFBP-3, 34 kDa IGFBP-2, and 28 and 24 kDa forms of IGFBP-4 in the serum, and 33 kDa IGFBP-2 and 29 kDa IGFBP-5 in the AP. Administration of E2 tended to increase ($P = .09$) relative amounts of 41 kDa IGFBP-3 in serum and increased

($P < .05$) relative amounts of IGFBP-2 and -5 in the AP. AP concentrations of LH tended to increase ($P = .09$) in E2 treated groups vs C. Administration of E2 increased serum and AP concentrations of IGF-I, relative amounts of serum and AP IGFBPs, and LH (AP). These data suggest E2 may influence AP function in the pig through changes in serum and AP concentrations of IGF-I and relative amounts of serum and AP IGFBPs.

Key Words: Estradiol, IGF-I, Pig

223 The effect of alternating fetal crushing on the growth of remaining conceptuses in Yorkshire (Y) and Meishan (M) pigs. K.A. Vonnahme*, M.E. Wilson, and S.P. Ford, *Iowa State University, Ames*.

Our laboratory has demonstrated that in response to increasing fetal demands, Y placentae increase in size and surface area during the final trimester of gestation. In contrast, M placental size remains constant, but the density of blood vessels at the placental-endometrial interface increases markedly. Preliminary observations suggest if one of two adjacent M conceptuses dies, the placenta of the remaining M conceptus does not "invade" the newly vacated space, while placentae of Y conceptuses "invade" these adjacent, unoccupied spaces. The objective of this experiment was to confirm that Y, but not M conceptuses increase placental size when adjacent conceptuses are experimentally destroyed. On d 40 of gestation, straight-bred M (n=8) and Y (n=8) females were laparotomized and one uterine horn was randomly assigned to receive alternating fetal crushing (AFC), while the other horn served as the control. Every other fetus in the AFC horn was then crushed through the uterine wall. Fetal weight (g), crown-rump length (CRL, cm), placental weight (PLWT, g), implantation site length (cm), and placental surface area (PSA, cm²) were recorded at slaughter on d 112 of gestation. Although Y fetuses were heavier and larger ($p < .05$) than M fetuses, no difference in fetal weight or CRL was observed between AFC or control horns of either breed. However, while there was no difference in PLWT, PSA or implantation site length between M AFC and control horns (173.8 \pm 6.4g, 1162.7 \pm 35.9 cm², 19.0 \pm .4 cm), PLWT, PSA and implantation site length were increased ($p < .05$) in Y AFC horns compared to Y control horns (306.1 \pm 26.0 g, 1834.9 \pm 93.9 cm², 33.4 \pm 1.5 cm vs 253.7 \pm 13.4 g, 1474.3 \pm 50.4 cm², 27.2 \pm .8 cm; respectively). Thus, Y conceptuses, but not M conceptuses, increase placental size when given the opportunity to occupy more uterine space. These data indicate that differences exist in the strategies employed by M as compared to Y conceptuses in the competition for nutrients during gestation.

Key Words: Placental growth, Gestation, Pig

224 Transrectal ultrasonography in gilts. C.J. Bracken*, M.C. Lucy, and W.R. Lamberson, *University of Missouri, Columbia, MO, USA*.

Development of transcutaneous and transrectal ultrasonography during the past decade has allowed researchers and, more recently, producers to use this technology for diagnosing pregnancy and ovarian functions. But, transrectal ultrasonography could only be performed in sows. Recently, a method has been developed to enable the study of follicular growth and ovulation in gilts. The method employs a handle that is fitted on to the ultrasound probe. The handle consists of a 60 cm section of 1.27 cm diameter polyvinyl carbonate (PVC) pipe, that is grooved for the 7.5 MHz linear transducer and has a 40-45 $^\circ$ angled head for appropriate positioning over the ovaries. The ultrasound probe is attached to the handle and inserted into the rectum of the gilt and the probe head is slid over the pelvis and bladder. The ovaries are located anterior and lateral to the bladder. The transrectal technique was used in a study in which follicles and corpora lutea were counted and the time of ovulation was measured in gilts. Ultrasonographic measurements were taken every six hours from first detection of estrus until ovulation as determined by the complete absence of follicles (n = 42 gilts). Time of ovulation was readily measured by observing disappearance of follicles. Follicle counts were only moderately consistent across repeated measurements (r = .43). Follicle numbers counted via ultrasonography underestimated ovulation rate estimated by the number of corpora lutea (CL) subsequently counted at laparotomy (11.2 \pm .25 follicles v. 14.5 \pm .34 corpora lutea; $P < .01$). The ultrasound method will be useful

for observing ovarian follicular growth and ovulation in gilts and should lead to improvements in gilt reproductive management.

Key Words: Gilt, Ovary, Ultrasonography

225 Mechanism of Inhibin action. T. K. Woodruff*, *Northwestern University.*

Inhibin plays critical paracrine and endocrine roles in downregulating pituitary FSH and absence of inhibin results in ovarian and testicular cancer in knockout mice. Until now, the downstream signaling proteins in the inhibin signal transduction cascade have been unknown, largely because an inhibin receptor has not been identified. The inhibin receptor has eluded us because no inhibin ortholog exists outside of vertebrates and because the nature of the receptor is fundamentally different from other receptor subunits in the TGF β superfamily. An inhibin binding protein has been identified. FSH and the inhibin binding protein co-localize in the pituitary, indicating that the isolated protein is present in the inhibin target cell, the gonadotrope. In addition, the inhibin binding protein is abundant in the testicular Leydig cell, a compartment enriched for inhibin binding sites and devoid of activin binding sites. The purification and cloning of an inhibin-binding protein provides a key reagent to our further understanding of the mammalian reproductive axis as well as the origin of reproductive oncogenesis.

Key Words: Ovary, Inhibin, Pituitary

226 Physiology and expression of inhibin/activin transcripts and different molecular forms of inhibin protein during follicle development in pigs. H. D. Guthrie*¹, W. M. Garrett¹, and S. O. Mack², ¹*Germplasm and Gamete Physiology Laboratory, ARS, USDA, Beltsville, MD 20705*, ²*Dept. of Physiology and Biophysics, Howard University, Washington, DC 20059.*

Inhibins and activins were initially isolated as gonadal proteins with the capacity to inhibit and stimulate, respectively, FSH secretion and its synthesis in anterior pituitaries. The predominant I/A form produced in the ovary may be inhibin A or B. Comparison of immunoblots of nonreduced and reduced follicular fluid indicate that the four predominant forms 121, 69, 227, and >227 kDa (representing 83% of total inhibin immunoblot activity) are probably composed of α/β dimers. In addition, the order of abundance of I/A transcripts is $\alpha > \beta_A > \beta_B$ in follicular tissue. The abundance of the α mRNA may exceed that of the β_A by 5 to 20-fold. The predominant I/A form produced in the pituitary may be one of the activins as β_A and β_B mRNA are present in approximately equal abundance, while α mRNA is non-detectable. The expression of α and β_A mRNA in granulosa cells is positively correlated with expression of aromatase protein, follicle growth, and with expression of a cell proliferation marker (the cell proliferation-associated nuclear antigen Ki-67). In addition, expression of both α and β_A mRNA were also positively correlated ($p < .05$) with follicular diameter and with follicular estradiol during the period of selection and growth in the presumptive ovulatory follicles. In large follicles following the preovulatory LH surge expression of α mRNA decreased ($p < .05$) by 72% while β_A and β_B mRNA decreased to low to non-detectable levels. Activin has been shown to inhibit granulosa cell steroidogenesis in vitro, suggesting an atretogenic role. However, during atresia expression of α and β_A mRNA were reduced by 66-83% ($p < 0.001$) compared to nonatretic follicles. Total inhibin immunoblot activity was 59% less in atretic than in nonatretic follicles and amounts of the 44-, 49-, 69-, 121- and 227-kDa forms were 50 to 80% lower ($p < 0.05$). In summary, in addition to regulation of FSH secretion, the expression of I/A subunits and proteins in granulosa cells is related to the physiology of follicle growth in a positive way that appears to be independent of changes in FSH secretion.

Key Words: inhibin, activin, apoptosis

227 Inhibin production and secretion by granulosa-thecal cell tumors in mares. M.T. Bailey, S.A. Christman, M.H.T. Troedsson, M.M. Ababneh, and J.E. Wheaton*, *Department of Animal Science, University of Minnesota.*

Plasma inhibin concentration has proven useful as a diagnostic indicator of the presence of a granulosa-thecal cell tumor (GTCT) in mares. We have conducted studies to learn more about production and secretion of

inhibin by GTCT. Dimeric inhibin ($\alpha\beta$) is composed of disulfide linked α - and β -subunits and in order to specifically measure $\alpha\beta$ a two-site immunoradiometric assay was developed. Antibodies against α - and β -subunits also were used to immunohistochemically identify cell types producing inhibin subunits. Results of an initial study showed that concentrations of $\alpha\beta$ were greater ($P = 0.04$) in single plasma samples from six GTCT mares than in 12 normal cycling (control) mares. Plasma $\alpha\beta$ concentrations in two GTCT mares overlapped with those in control mares. Concentrations of $\alpha\beta$ in GTCT fluid and equine follicular fluid (eFF) were similar and plasma concentrations were greatest in mares with large GTCT. Results suggest that elevated plasma concentrations in GTCT mares are attributable more to GTCT mass than to increased secretory output. Positive α - and β -subunit immunostaining was seen in granulosa cells but not in thecal cells. Large polyhedral-shaped cells were present in the thecal/stromal layer of 3 of 6 tumors examined, and these cells stained positively for both inhibin subunits. Abundance of polyhedral cells was associated with the concentration of testosterone in GTCT fluid. An α -inhibin radioimmunoassay was developed that utilized just antibody against the α -subunit, thus capable of detecting $\alpha\beta$ as well as free α -subunit. Concentrations of $\alpha\beta$ and α -inhibin in single plasma samples from 22 GTCT and 31 control mares were elevated ($P < 0.001$) 5.7- and 20.5-fold, respectively, over control concentrations. Concentrations of $\alpha\beta$ in eight GTCT mares and α -inhibin in five GTCT mares overlapped with those in control mares. Serial blood samples were collected from one GTCT mare during a 21-day period. Concentrations of α -inhibin were relatively constant, whereas $\alpha\beta$ concentrations were more variable. Testosterone concentrations also were variable, ranging from non-detectable to > 250 pg/mL. Concentrations of α -inhibin seem to be better suited than $\alpha\beta$ as a diagnostic marker for GTCT.

Key Words: Inhibin, Mares, Ovarian tumors

228 Prostaglandin E₂ production in pig anterior pituitary cells treated with bacterial lipopolysaccharide. J. E. Minton* and C. M. Hill, *Kansas State University.*

We have shown previously that bacterial lipopolysaccharide (LPS) stimulated interleukin-6 mRNA and secretion from pig anterior pituitary cells in vitro, and that this effect of LPS was dependent on products of the cyclooxygenase (COX) pathway. Here, we tested the hypothesis that LPS-stimulated prostaglandin E₂ (PGE) in cultured pig pituitary cells was dependent on inducible COX-2. Pituitary cells from barrows were collected immediately after slaughter, taken to the laboratory and subjected to mechanical and enzymatic dispersion. Cells were plated at 500,000/well and incubated in a humidified environment at 37 °C and 5% CO₂ for 96 h. The cells were washed with serum-free media and treated with substances of interest. After incubation, the media was removed and frozen for later determination of PGE using a specific ELISA. Each experiment was repeated twice, with 4 to 8 animals represented in each. Representative data from individual experiments are presented. Cells from each animal were subjected to every treatment in a given study. In the first experiment, cells were treated with 0, .1, and 1 $\mu\text{g}/\text{ml}$ LPS and media was removed after 3, 6, 12, and 24 h. PGE was increased in media from cells treated with 1 $\mu\text{g}/\text{ml}$ LPS at 12 h ($P < .07$). After 24 h, both .1 ($P < .05$) and 1 $\mu\text{g}/\text{ml}$ ($P < .0001$) LPS had increased PGE above control wells. In the second experiment, cells were treated with .1 $\mu\text{g}/\text{ml}$ LPS for 24 h in the presence of inhibitors of COX-2 (NS-398), cytosolic phospholipase A₂ (AACOCF₃), and the lipoxygenase pathway (NDGA). Drug treatments were tested at 10⁻⁸ to 10⁻⁶ M. As expected, LPS stimulated PGE production ($P < .01$), and this increase was inhibited completely by NS-398 at 10⁻⁶ M. Neither AACOCF₃ or NDGA affected LPS-stimulated PGE. We conclude that LPS stimulates PGE in a time and dose-dependent fashion in cultured pig anterior pituitary cells and that the stimulation is dependent on COX-2.

Key Words: anterior pituitary, lipopolysaccharide, prostaglandin E₂

229 A comparison of the immunological response to Lipopolysaccharide (LPS) versus E.coli challenge in the weaned pig. M.E. Zannelli^{*1}, K.J. Touchette², G.L. Allee², R.L. Matteri³, L.A. Beausang¹, L.J. Luchene¹, and J.A. Carroll³, ¹Endogen, Inc., Woburn, MA, ²University of Missouri-Columbia, ³Animal Physiology Research Unit, Agricultural Research Service, USDA, Columbia, MO.

The objective of this study was to evaluate potential differences in immunological responses between an LPS and E.coli challenge in the weaned pig. Forty weaned pigs (14d, 5 kg) were used in 2 experiments (EXP 1 and 2). In EXP 1, pigs were allotted to 1 of 2 treatments: 1) Cont; i.p. injection of saline or 2) i.p. injection of LPS (150 µg/kg BW). In EXP 2, pigs were also allotted to 1 of 2 treatments: 1) Cont; oral dose of sterile culture media (5 ml) or 2) 5 ml oral dose of E.coli (100 million CFU/ml). Starter rations were fed for 7d prior to immunological challenges. On d6 post weaning, all pigs were non-surgically fitted with a jugular cannulae. On d7 of EXP 1, pigs received their respective i.p. treatments followed by collection of blood samples every 15 min for 3hr. On d7 of EXP 2, pigs received their respective oral treatment doses followed by collection of blood samples for 10hr. Serum TNF-α and IFN-γ were assessed by porcine specific ELISAs. In the LPS challenged group, there was a time by treatment effect for serum TNF-α (P<.0001) and IFN-γ (P<.0001), where the first significant difference in serum TNF-α was at 0.75hr with 1.38ng/ml (P=.01). Peak TNF-α concentration was 10.85ng/ml at 1.25hr post-LPS. The first significant difference in serum IFN-γ was at 1.75hr with 187.1pg/ml (P=.01). Peak IFN-γ concentration was 995.4pg/ml at 3hrs. In the E.coli challenged group, there was no difference in the serum TNF-α (P=.69), however, there was a significant time by treatment difference in serum IFN-γ (P<.001). There was a trend for E.coli to increase serum IFN-γ beginning at 5hrs compared to controls (P=.14). Peak IFN-γ concentration was 26.2pg/ml at 7hrs and remained at that level for the remainder of the study. These results demonstrate that LPS and E.coli challenges induce very different immunological profiles in the weaned pig.

Key Words: Immune Function, Cytokines, Pigs

230 Function of the reproductive system of neonatal pigs born naturally or by Cesarean section. J.A. Daniel^{*1}, D.H. Keisler¹, C.J. Dyer², R.L. Matteri², and J.A. Carroll², ¹University of Missouri-Columbia, ²Animal Physiology Research Unit, Agricultural Research Service, USDA.

Ten full term pregnant crossbred sows were selected for a study to compare function of the reproductive system of pigs born by Cesarean section (c-section) or natural-birth (n = 5 each for natural-birth and c-section). Gestation length and birth weight did not differ between natural-birth and c-section pigs (P = .84 and .69, respectively). Blood and tissue samples were collected from 45 pigs at birth and 41 pigs at 14 d of age. Day 14 pigs received an i.v. injection of GnRH (2.5 µg/kg) or saline at min 0, blood serum samples were collected at -60, -45, -30, -15, 0, 15, 30, 45, 60, 90 and 120 min, and tissue samples were collected immediately following the 120 min sample. Serum concentrations of cortisol (CS), ACTH, LH, and FSH were determined by RIA. Expression of GnRH, GnRH receptor, LH and FSH alpha and beta subunits, and LH and FSH receptor were determined by slot blot. Centrifuge clot-to-blood ratio was greater among natural-birth than c-section pigs at birth (P < .01) but did not differ at 14 d (P = .16). Basal serum ACTH did not differ between c-section and natural-birth pigs at birth or 14 d (P > .20), but basal serum CS was greater in c-section than natural-birth pigs at birth and 14 d (P < .02). Basal serum FSH decreased from birth to 14 d (P < .0001) and was greater in gilts than boars (P < .0001). Treatment with GnRH significantly increased FSH in gilts (P < .0001), but not in boars (P = .61). Basal serum LH was not affected by birth type or age but was greater in boars than gilts (P < .0001). Interestingly, c-section boars had a much greater LH response to GnRH challenge than natural-birth boars (P < .01). Response of LH to GnRH challenge did not differ in gilts (P = .89). Type of birth did not significantly affect expression of the mRNAs examined in the current study. These data indicate that c-section birth alters function of the reproductive system in male neonatal pigs.

Key Words: Cesarean Section, Pigs, Reproduction

231 Characterization of the gene for porcine endometrial/placental membrane folate binding protein (mFBP). J. L. Vallet*, T. P. L. Smith, T. S. Sonstegard, M. P. Heaton, and S. C. Fahrenkrug, USDA, ARS, RLH US Meat Animal Research Center, Clay Center, NE.

The developing conceptus and the fetal erythron require high levels of folate. Endometrial cDNAs for secreted and membrane folate binding proteins have been characterized. To characterize the gene for mFBP, yeast artificial chromosome (YAC) and bacterial artificial chromosome (BAC) libraries were screened using primers and a probe specific for the mFBP cDNA. Half the mFBP gene was subcloned from a YAC clone into the SuperCOS vector and sequenced. The rest of the gene (bases 5607 to 9106) was obtained from a BAC clone. The mFBP gene is composed of 5 exons (exon 1 = 68 bp, bases 1797-1864; exon 2 = 194 bp, bases 5312-5505; exon 3 = 189 bp, bases 6879-7067; exon 4 = 136 bp, bases 8070-8205 and exon 5 = 421 bp, bases 8350-8770). The size of the last three exons were conserved among members of the FBP/folate receptor family, while the size of the 5' exons varied. The previously reported heterogeneity in the 5' end of the mFBP mRNA corresponded to transcription starting at exon 1 or 2, suggesting that the mFBP gene has two promoter regions. Possible transcription factor binding sites 5' of exon 1 included: CCAAT binding factor (CBF) sites at 1016, 1352, and 1542 bp, c-myb (ATTGAA) sites at 259 and 1069 bp, myc associated zinc finger protein (MAZ; GGGAGGG) sites at 644 and 988 bp, and a peripherin-2 (CCCCACCCCC) site at 1669 bp. Possible transcription factor binding sites 5' of exon 2 included: CBF sites at 2015, 4112, and 4847 bp, an activator protein (AP)-1 site (TGAATCA) at 2269 bp, AP-2 sites (TGGGGA) at 3070, 4011, 4371, and 5160 bp, a c-myb site at 5285 bp, a c-myc site at 2685 bp, lymphocyte factor-1 (TCTCCAGG) sites at 3296 and 4827 bp, and MAZ sites at 2678, 2888, 3078, and 3365 bp. These results suggest candidate transcription factors controlling the mFBP gene. Manipulation of these factors may allow improved delivery of this vitamin during pregnancy, resulting in increased litter size in swine.

Key Words: Uterus, Pregnancy, Erythropoiesis

232 Regression of non-suckled mammary glands during lactation in sows as influenced by dietary nutrients. S. W. Kim*, W. L. Hurley, and R. A. Easter, University of Illinois.

Sixty nine primiparous sows were used to characterize regression of non-suckled mammary gland during lactation as affected by nutrition. Sows were fed four diets containing combinations of two protein (32 or 65 g lysine/d) and two energy (12 or 17.5 Mcal ME/d) levels during lactation. Litter size was set to 9 or 10 pigs within 48 h after farrowing by cross fostering. Sows had 2 to 6 non-suckled mammary glands depending on their litter size and the number of mammary glands. Sows were slaughtered on d 0 (within 12 h after farrowing), 5, 10, 14, 21, and 28 of lactation. On the day before slaughter, sows and litters were observed to identify non-suckled glands. At slaughter, skin and extraneous fat pads were removed from the mammary glands and mammary tissue was separated into individual glands. Each gland was weighed (wet weight), cut in half to measure cross-sectional area, and ground for measuring DNA content. Only mammary glands known to be non-suckled were included in this data set. The regression of non-suckled mammary glands occurred rapidly during the first week of lactation. Tissue regression resulted in significant (P < .05) decreases of gland wet weight, DNA content, and smaller cross-sectional area. There were no further changes in gland composition up to the fourth week of lactation. Regression of non-suckled glands was affected by nutrient intake (P < .05). At d 5 of lactation, sows on high-energy high-protein diet had 91% heavier wet weight (P < .05) of non-suckled mammary glands than those with low-energy low-protein group, while wet weight of non-suckled glands of sows in the high-energy low-protein and low-energy high-protein diet groups were intermediate. These results indicate that mammary gland regression occurred more slowly in sows receiving a high-energy high-protein diet than a low-energy low-protein diet. Differences in wet weight among dietary groups persisted at least until d 28 of lactation (P < .05). Regression of non-suckled mammary glands was affected by the dietary nutrient level that sows received during lactation. Tissue regression in non-suckled glands occurred more slowly during early lactation and resulted in greater residual mammary tissue by the end of lactation in sows fed high nutrient level compared with sows fed low nutrient level.

Key Words: Sow , Mammary Gland Regression, Lactation

233 Differences in serum immunoglobulin G1 and total protein concentrations in neonatal calves on days 1, 5, and 10. L.E. Wankel*, T.T. Marston, G.L. Stokka, and T.G. Rozell, *Kansas State University, Manhattan.*

Studying immunoglobulin G1 (IgG1) serum concentrations are an accurate way to evaluate passive transfer of immunity in neonatal calves. In addition, total proteins may be measured to evaluate health, as well as whether an immune response has been elicited. When measuring IgG1 and total protein concentrations it is imperative to collect samples within a narrow window of time to avoid sacrificing accuracy. Thus, the objective of this study was to determine if serum IgG1 and total protein concentrations differed significantly in neonatal calves on days 1, 5, and 10 to ensure precise results. Beef calves (n = 10) born within 6 days of each other were selected at random. Blood was harvested via jugular veni-puncture when calves were 1, 5, and 10 d of age. Samples were then centrifuged to collect serum. Serum samples were analyzed for IgG1 concentrations using radial immunodiffusion kits specific for bovine IgG1. Total proteins were analyzed using a temperature-compensated hand-held refractometer. Serum concentrations for total protein declined from d 1 to 5 (P < .05) and from d 1 to 10 (P < .05). However, d 5 and 10 were not different (P = .46). IgG1 serum concentrations were similar from d 1 to 5 (P = .17), and values for d 5 to 10 approached significance (P = .06). Nonetheless, d 1 and 10 differed significantly (P < .05). These results indicate that when conducting research assessing passive transfer of immunity, IgG1 should only be measured at d 1 to 5 to secure accurate data involving IgG1. In spite of this, blood should be amassed at d 1 if total proteins are read along with IgG1 due to the difference in total protein concentrations between d 1 and 5.

Key Words: Immunoglobulin G1, Total protein, Neonatal calves

235 Effects of gonadotropin treatment on incidence of estrus and pregnancy rate in ewes synchronized with Synchro-Mate-B (SMB) and subjected to laparoscopic artificial insemination (LAI) during the breeding season. D.A. Redmer*¹, R.G. Haugen¹, T.K. Stenbak¹, D.R. Arnold¹, M. J. Toutges¹, H.R. Berginski¹, C. Navanukrow¹, W. Limesand¹, J. D. Kirsch¹, K. C. Kraft¹, J. J. Bilski¹, A.T. Grazul-Bilska¹, D.D. Gourley², R.L. Riese², and L.P. Reynolds¹, ¹*North Dakota State University, Fargo, ND*, ²*Elite Genetics, Waukon, IA.*

Direct intrauterine insemination by laparoscopy is a powerful tool for genetic progress in sheep. LAI is most practical when combined with estrus synchronization and timed insemination. Our hypothesis was that treatment with gonadotropins would improve the incidence of estrus and pregnancy rate in ewes synchronized with SMB and subsequently subjected to timed insemination by LAI during the breeding season (Aug.-Sept., 1999). Purebred Hampshire and Montadale ewes were implanted with SMB for 14 days and randomly assigned to one of four gonadotropin treatments (n=20/group) in a 2 x 2 factorial design (+/- PMSG and +/- GnRH). Ewes received i.m. injection of pregnant mare's serum gonadotropin (PMSG; Folligon, Intervet, Whitby, Ontario; 400 IU) or vehicle (V1) at SMB removal and gonadotropin releasing hormone (GnRH; Cystorellin, Merial, Athens, GA; 25 mcg) or vehicle (V2) at 36 hr after SMB removal. Vasectomized rams with markers were penned with the ewes at SMB removal and estrous activity was recorded. All ewes were subjected to LAI at 58-60 hr after SMB removal. Intact rams with markers were turned in with the ewes 10 days after LAI and rebreeding was recorded. Ewes were evaluated for pregnancy 35-40 days after LAI by real-time ultrasound; only pregnancies resulting from LAI were recorded. No differences were observed among treatments (P>0.10; chi-square test) for any of the variables measured. Percent of ewes in estrus by 60 hr after SMB removal was 89.5, 70.0, 77.8, and 90.5 for V1/V2, V1/GnRH, PMSG/V2, and PMSG/GnRH treatments, respectively. Pregnancy rate (percent pregnant to LAI) was 47.4, 50.0, 66.7, and 47.6 for V1/V2, V1/GnRH, PMSG/V2, and PMSG/GnRH, respectively. Percent of ewes that were rebred at the next estrus after LAI was 52.6, 40.0, 38.9, 47.6% for V1/V2, V1/GnRH, PMSG/V2, and PMSG/GnRH, respectively. These data indicate that treatment with PMSG and/or GnRH does not improve the estrous response or pregnancy rate to timed insemination by LAI in seasonally estrous ewes synchronized with SMB. Supported in part by Hatch project ND 01705.

Key Words: Artificial insemination, Estrous synchronization, Ewe

RUMINANT NUTRITION AND FORAGES

237 The history and current usage of liquid supplements. R. H. Klett*¹, M. J. Prokop², and D. L. Williams³, ¹*X F Enterprises, Greeley, CO*, ²*Liquid Feed Commodities, Fremont, NE*, ³*Purina Mills, Inc., St. Louis, MO.*

From use of straight molasses at its inception to the complex feedlot suspensions of today, the liquid supplement industry has developed into an industry with significant benefits for the cattle industries. Past development of liquid feeds followed two lines: the use of urea as a source of dietary NPN, and the use of molasses as a livestock feed. In the US, molasses was first fed in 1890, and a more complex molasses-urea product was first fed to dairy cattle in 1943 and to beef cattle in 1949, with the first commercial liquid supplement being introduced in 1951. The first US patent on an exclusive line of liquid supplements combining molasses, urea, and phosphoric acid was in 1957. New developments in manufacturing technology and ingredient utilization have provided products that are safe, convenient, and effective, and have many advantages over dry supplements. Some of the early molasses-urea mixes used for free-choice and feedlot applications produced variable results because of ingredient separation, and poor intake limiting ability when fed free-choice. Today, a wide array of ingredients are suspended using agents such as attapulgit clay and xanthan gum; urea products are now "protected" and less toxic; higher levels of natural proteins can be included; and fats, vitamins, minerals, and feed additives are included in formulas. Technology advances in the liquid feed industry have produced self-hardening poured blocks that are a convenient way of providing supplements. A survey by AFIA showed that production of manufactured liquid feeds in 1998 was 1,054,000 tons for grass cattle and dairy, and 883,000 tons for feedlot use. Since 1990, the tons of liquid feed sold has increased 51% for grass cattle and dairy, and 43% for feed-

lot use. A survey by Cattle-Fax for AFIA of private and feed company feedlot nutritionists in 1999 showed that 59% used both liquid and dry supplements, and of those that used a dry supplement, 59% also used a simple blend or single liquid ingredient. This survey indicated that over 60% of the cattle fed in the US receive their supplemental nutrition from liquid supplements. This number has increased by 25% between 1993 and 1999.

Key Words: Liquid Supplements, Cattle

238 New technologies in liquid supplementation. J. S. Drouillard*¹ and J. M. Harris², ¹*Kansas State University, Manhattan, KS*, ²*Westway Trading Corp., Tomball, TX.*

Free-choice supplements are recognized as a convenient mechanism for delivering supplemental nutrients to cattle, and their use is becoming increasingly popular in grazing applications. Ingredient formulation capabilities for liquid supplements have been enhanced through development of suspension systems in which dry ingredients are suspended in an aqueous phase using gums, clay gelling agents, or starches. Improved emulsion technologies have allowed for incorporation of significant quantities of fats and oils into aqueous-based supplements. Regulation of supplement consumption by livestock has been the subject of recent technological improvements in liquid dispensing systems. Liquid feed ingredients also are used extensively in manufacturing block supplements. Blocks vary widely in terms of their cost, agglomeration principles, ingredient composition, nutrient profile, manufacturing methods, capital investments for manufacturing equipment, packaging requirements, storage characteristics, and consumption characteristics. Blocks generally

fall into one of three major categories, including 1) pressed blocks, which are produced by blending ingredients and subsequently forming into the desired shape by compressing the mixtures under high pressure, 2) chemical process, in which liquid and dry ingredients are combined into a slurry that ultimately forms a hardened mass due to interactions between water and mineral oxides and/or clay gelling agents, and 3) deliquescent blocks, which rely on the near complete evaporation of moisture from molasses to produce a taffy-like material that is subsequently blended with dry ingredients and cooled to form a solid mass. These processes yield products with distinctive characteristics that are suited to distinct market niches. Liquid-based, self-fed supplements frequently provide a convenient, competitive method of delivering supplemental nutrients or feed additives to grazing cattle with minimal labor and relatively low investment in equipment.

Key Words: Liquids, Blocks, Supplements

240 Formulating diets using liquid supplements for growing and finishing cattle. R. H. Pritchard*¹ and M. Sindt², ¹South Dakota State University, Brookings, SD/USA, ²Midwest P.M.S., Scottsbluff, NE/USA.

Liquid supplements have evolved from using liquefied feedstuffs as carriers for incorporating micro-ingredients into cattle diets. They have been used to carry sugars, starch, fats, urea, proteins, minerals, vitamins, and non-nutritive additives. Properly managed liquid supplements can create a greater dispersion of micro-ingredients throughout the diet. This is accomplished by coating a primary diet component with the liquid supplements. Separation that can occur when handling feeds containing meal or pelleted forms of supplements is less likely to occur with liquid supplements and may represent a major benefit of these products. Effective use of liquid supplements will require different handling and management procedures than are common for dry supplements. The liquid supplement inclusion must be on to feeds that have minimal surface friction to ensure uniform dispersion. The adhesive characteristics that improve mixed feed stability will increase product retained by feed handling equipment. Formulations used in liquid supplements must allow for possible ingredient separation during storage. There are important differences depending upon whether the additives are in solution or suspension and the matrix system inherent in the liquid supplement carrier. Shelf-life of organic compounds is different in various types of liquid supplements and may differ from dry supplements. Liquid supplements can be used to enhance the feed mixing characteristics of many types of cattle diets.

Key Words: Liquid supplement, Cattle, Feed mixing

241 Meeting nitrogen requirements of beef cows with liquid supplements. J. A. Paterson*¹ and R. Rawlings², ¹Montana State University-Bozeman, ²PerforMix Nutrition Systems, Nampa, ID.

The usage of liquid supplements for grazing cattle continues to increase in the U.S. Reasons for increased usage of self-fed supplements is due to reducing labor, equipment and storage costs and the availability of sources of industrial liquid byproducts; condensed molasses fermentation solubles, corn steep liquor, condensed distillers solubles and condensed whey. Liquid supplements can provide sources of degradable intake protein (DIP), fat, macro- and trace minerals and other feed additives because of advances in suspension technologies. Florida workers suggested that there were no obvious differences between liquid and dry supplements with regard to effects on forage intake. Voluntary intake may be increased or decreased by the feeding of either dry or liquid supplements. Positive responses in stimulating forage intake appeared to be related to the ratio of forage TDN:CP. If the ratio was > 12, or when forage intake was < 1.75% of BW, supplements increased forage intake. Rumen microorganisms must have a source of DIP in order to effectively digest dietary fiber. Nebraska workers determined that DIP was deficient during Sept through Jan for cows grazing native range. Depending on the production requirements for growth, lactation and gestation, additional undegradable intake protein (UIP) may or may not be required in the diet above which meets the DIP requirement. If meeting the DIP requirement through supplementation resulted in the total metabolizable protein (MP) requirement being met, then supplementing with additional UIP should have no effect on animal performance. The 1996 NRC Beef Requirements software allows the nutritionist to model

periods of the year when dietary DIP is deficient and requires supplementation. Accurate estimates of grazed forage intake, degradability of the forage and supplement, efficiency of microbial protein synthesis and potential ruminal associative effects are needed before making supplementation recommendations. Estimating MP and DIP balance when comparing liquid supplements to other supplements can help explain expected animal performance responses.

Key Words: Liquid supplement, Beef cattle, DIP

242 Effect of variety, stages of maturity and botanical fractions on phosphorous content, in situ degradability and availability of phosphorous of whole crop rice silage for ruminants. M. R. Islam*¹, M. Ishida¹, S. Ando¹, T. Nishida¹, and N. Yoshida², ¹National Grassland Research Institute, Tochigi, Japan, ²Saitama Agriculture Experiment Station, Saitama, Japan..

The effect of 7 varieties of whole crop rice harvested and ensiled each at 4 stages of maturity was investigated for phosphorous (P) content, in situ degradability of P and its ruminal availability in a 7 x 4 factorial experiment. Rice (Akichikara, Fukuhibiki, Habataki, Hamasari, Kusanami, Tamakei 96 and Yumetoiro) was grown in Saitama, Japan during 1997-98 and harvested at 10, 20, 30 and 40 days after flowering. Each variety at each stages of maturity was ensiled and between 45 to 49 days after ensiling, silages were opened and grounded green to pass through 4-mm screen. All silages incubated in the rumen of two Holstein steers for 3, 6, 9, 12, 24 and 48 h over seven periods. 0-h bags washed using washing machine followed by cold tap water. Silages were also fractionated into leaf blade (LB), leaf sheath (LS), stem (S) and head (H). Variety and maturity affected significantly ($P < 0.01$) on P content, in situ degradability of P of silages. Significant ($P < 0.05$) interactions between variety and maturity also existed in above parameters. P content, immediately soluble and ruminally available P decreased ($P < 0.01$) with the increase in stages of maturity. Botanical fractions of a wilted silage (Hamasari) were investigated for P content and in situ degradability. Head contains higher ($P < 0.001$) P, but lower ($P < 0.001$) soluble P than leaf or stem. Ruminally P availability was the highest ($P < 0.001$) from stem. Proportion of H negatively correlated ($P < 0.001$) to P content, P solubility and ruminal availability, but leaf or straw components were positively correlated ($P < 0.001$) to those parameters. The results indicate that P availability in animals may vary due to the differences in variety and stages of maturity of silage. Botanical fractions may also have important implications on P availability from whole crop rice silages.

Key Words: Phosphorous, Variety, Maturity

244 Effects of grazing crop residues from bt-corn hybrids on the performance of gestating beef cows. J.R. Russell*, M.J. Hersom, A. Pugh, K. Barrett, and D. Farnham, Iowa State University, Ames.

One non bt-corn hybrid (Pioneer 3489), two bt-corn hybrids with the Yieldguard event (Pioneer 34RO7 and Novartis NX6236), or one bt-corn hybrid with the Knockout event (Novartis N64-Z4) were seeded in duplicate 2.9-ha fields. On September 4, 50 plants were collected from each field and examined for corn borers. After grain harvest, each field was divided into four paddocks and dropped corn ears were collected from two 4-m² locations per paddock. Thirty crossbred cows in mid-gestation were allotted to duplicate drylots or the eight crop residue fields to strip-graze for 126 d. Cows were condition-scored biweekly and alfalfa hay was offered to maintain a condition score of five on a nine-point scale. Crop residues were collected from one 4-m² location within each grazed or ungrazed paddock during grazing and from four 4-m² grazing enclosures at grazing termination. After 14 d of grazing, forage selected during 2 h of grazing after ruminal evacuation of one fistulated steer per field or drylot were collected, freeze-dried and analyzed. Proportions of corn plants with corn borers in the upper and lower stalk and ear shank were greater ($P < .05$) in the 3489 hybrid than in the three bt-hybrids. Harvested grain yields and the densities of dropped ears and grain did not differ between hybrids. At the initiation of grazing, crop residues from NX6236 and N64-Z4 corn had higher ($P < .05$) IVOMD concentrations and lower concentrations of ADF ($P < .05$) and ADL ($P = .07$) than 3489 or 34RO7 corn. Corn hybrid did not affect the rate of change in the concentrations of IVOMD, NDF, ADF, ADL, CP, or ADIN over the winter. Concentrations of CP were higher ($P < .05$) and ADIN concentrations were lower ($P < .05$) in forage selected by steers grazing crop

residues from the 3489 hybrid than the N64-Z4 hybrid. Amounts of hay required to maintain a condition score of 5 by cows grazing corn crop residues were 836 kg DM/cow less ($P < .05$) than those maintained in the drylots, but did not differ between different hybrids.

Key Words: Beef cows, Corn crop residues, Grazing

245 Beef cow-calf and forage production and legume persistence from pastures containing systems. M. L. Hermann* and J. R. Russell, *Iowa State University, Ames.*

Cow-calf and forage production and legume persistence were evaluated in smooth bromegrass (SB) or alfalfa-grass pastures grazed by different stocking systems. Six 2.02-ha pastures were seeded in 1997 with "Barton" SB, a mixture of "Amerigraze" alfalfa (a grazing tolerant hybrid) and "Barton" SB, or a mixture of "Affinity" alfalfa (a hay-type hybrid) and "Barton" SB for season-long stocking. Four pastures were seeded with "Barton" SB in 1.21 ha and mixtures of "Amerigraze" or "Affinity" alfalfa and "Barton" SB in .81 ha to be grazed by complementary stocking. Pastures were divided into ten paddocks that were rotationally strip-stocked with crossbred cows at 1.98 cow-calf units/ha for 120 and 141 d beginning on May 18, 1998 and May 6, 1999, respectively. First cutting hay was harvested from 40% of each pasture in each year. Grazing occurred on the remaining 60% of each pasture for the first 44 d and 54 d and 100% of each pasture on d 45 to 120 and d 55 to 141 in 1998 and 1999, respectively. Daily and seasonal BW gains of calves were not affected ($P > .10$) by the presence of alfalfa in 1998 or by alfalfa hybrid and stocking system in 1998 and 1999. In 1999, pastures containing alfalfa had higher ($P < .05$) calf daily gains and seasonal BW production. Total and live forage masses were greater ($P < .05$) in May and September of 1998 from all alfalfa pastures than the season-long SB pastures and from season-long alfalfa pastures than pastures using alfalfa for complementary stocking. Total and live forage masses were greater ($P < .05$) in August of 1999 from season-long alfalfa pastures than pastures using alfalfa for complementary stocking. Proportions of "Amerigraze" and "Affinity" alfalfa in pasture live DM decreased by 70 and 55% in pastures stocked season-long and by 60 and 42% in pastures used for complementary stocking (Hybrid, $P < .05$; Grazing system, $P < .05$) in 1998, but decreased by a mean of 72% and was unaffected by hybrid or stocking system in 1999.

Key Words: Beef cattle, Grazing, Alfalfa

246 The effects of monensin on crude protein requirements of ruminal bacteria. C.J. Fu* and M.S. Kerley, *University of Missouri-Columbia.*

A single-phase continuous culture system with .09/hr dilution rates (D) was used to determine the effect of monensin (M) on microbial nitrogen production, microbial growth efficiency, and microbial nitrogen requirements at two ruminally degradable protein (RDP) levels. The basal diet was corn (CO) and casein (CA) was used as the RDP source. Four treatments were: CO, CO+M, CO+CA, and CO+CA+M. Monensin and casein levels were 80mg/kg and 8% on a DM basis, respectively. Urea, through the dilution media, provided ammonia for bacterial growth. Two culture runs were conducted with three fermenters allocated to each of the four treatments per run. The monensin did not affect true digestibility of dry matter (TDMD), organic matter (TOMD), and nitrogen (TND) ($P > .20$). Daily bacterial nitrogen flow (BACN), total nitrogen flow (TNF), ammonia, peptide, and microbial efficiency (MOEFF) were also not affected by monensin ($P > .20$). Monensin showed a trend to increase propionate ($P < .07$) concentration and decreased acetate to propionate ratio significantly ($P < .01$). Monensin decreased acetate and increased propionate mole percentage ($P < .02$, $P < .06$). Peptide-nitrogen requirement agreed with our previous studies (6.5% on a DM basis) and was not influenced by monensin. Adding RDP in the diets significantly increased peptide concentration ($P < .01$), ammonia concentration ($P < .01$), and TND ($P < .01$), and significantly decreased TDMD ($P < .03$) and TOMD ($P < .03$). The MOEFF and BACN showed a trend to decrease ($P < .13$, $P < .07$) by increased RDP. Ruminally degradable protein significantly decreased acetate ($P < .05$) and propionate ($P < .01$) concentration, but did not affect the acetate to propionate ratio. From this study, we conclude that monensin could potentially improve energy efficiency of the animal by increasing propionate proportion. The peptide from corn protein (1.5 mmol) and 1.7 mg/dl

ammonia maximized bacterial growth and MOEFF. Excessive RDP reduces bacterial growth and efficiency.

Key Words: Monensin, RDP, Microbial efficiency

247 Impact of frequency of supplementation on the forage use and performance of beef cattle consuming low-quality, tallgrass-prairie forage. C. G. Farmer*¹, R. C. Cochran¹, D. D. Simms², E. A. Klevesahl¹, and T. A. Wickersham¹, ¹*Kansas State University, Manhattan*, ²*Consolidated Nutrition, Omaha, NE.*

Two experiments evaluated the impact of various frequencies of supplementation on forage use and performance. In both experiments, the supplement was 43% CP and was fed at the following frequencies: 1) 2 days a week; 2) 3 days a week; 3) 5 days a week; and 4) 7 days a week. In Exp. 1, 120 Hereford \times Angus cows (BW=537 kg) grazing winter, tallgrass-prairie range were supplemented at the various frequencies from December 7 to calving (average calving date=3/7/99). Supplement was fed at 1.82 kg/ head daily for cows that received supplement daily, whereas other treatments allowed for the same amount of supplement to be fed on a weekly basis but equally split among supplementation events. Body condition and weight changes from December 7 to February 8 were improved (linear, $P = .02$) with increased frequency of supplementation, but the magnitude of differences in performance were relatively small. Treatment also tended (cubic, $P = .11$) to affect body condition change for the entirety of the trial. In Exp. 2, 16 ruminally fistulated Hereford \times Angus steers (BW=257 kg) were blocked by weight and assigned to one of the four frequencies of supplementation. Steers were offered tallgrass-prairie hay (73.5% NDF, 4.8% CP) ad libitum. Steers were supplemented at a similar rate as cows in Exp. 1 (relative to body weight) for the same frequencies of supplementation. Increasing frequency of supplementation improved (linear, $P \leq .02$) forage OM intake, OM and NDF digestion, and digestible OM intake. However, the most prominent differences in forage OM intake tended (cubic, $P = .07$) to be for the two extreme frequencies of supplementation. Forage DM intake for steers that received supplement two days a week was observed to decrease on the days they were supplemented. Forage use was improved with increased frequency of supplementation, but the impact on performance is not likely to be large unless extreme differences in frequency occur.

Key Words: Frequency, Supplementation, Forage

248 Selectivity of grazing cattle for birdsfoot trefoil and tall fescue in mixed pasture. L. Wen*, J.E. Williams, R.L. Kallenbach, C. Roberts, R.L. McGraw, P.R. Beuselinck, J.F. Thompson, L. Gebrehiwot, H. Benedict, and E. Navarro, *University of Missouri-Columbia, Columbia, MO USA.*

A three year project was conducted to investigate the effect of birdsfoot trefoil (BFT) interseeded in tall fescue (TF) on selectivity of steers grazing the forages. The five treatments were BFT with rhizomes (RBFT) and without rhizomes, TF, BFT/TF and RBFT/TF with 4 replicates (0.53 hectare) for each treatment. Four esophageal cannulated heifers were used to study the grazing selectivity of BFT/TF mixture. The heifers were confined to a pen with access to water 24 hr prior to sampling. Forage samples were clipped and hand-sorted into TF and BFT portions; each portion was fed to heifers separately and re-collected from the esophageal cannula, freeze-dried and ground. Standard mixtures of BFT and TF were used to calibrate each forage portion in the mixture grazed by heifers. Esophageal samples were squeezed and put on dry ice immediately after collection, freeze-dried and ground with dry ice. All samples were analyzed for NDF and CP by NIR. Samples were taken from each plot once a month from May through Nov. of 98 and from April to July of 99. Animals selected forage with less NDF ($P \leq 0.05$), more CP ($P \leq 0.05$) in BFT and TF mixture than that in TF. NDF contents selected from BFT/TF, RBFT/TF and TF were 32.9, 32.7 vs 35.3% ($P \geq 0.05$), respectively in summer 99; 55.5, 54.9 vs 61.1% ($P \leq 0.05$) in summer 98; 58.4, 55.3 vs 62.2% ($P \leq 0.05$) in fall 98. CP contents selected from BFT/TF, RBFT/TF and TF were 18.6, 18.2 vs 14.2% ($P \leq 0.05$), respectively in summer 99; 18.7, 19.0 vs 16.7% ($P \leq 0.05$) in summer 98; 15.3, 16.4 vs 13.7% ($P \leq 0.05$) in fall 98. In the summer 98 and 99, the percentage of BFT selected by heifers ($P \leq 0.05$) decreased, while the percentage of BFT in the pasture also decreased ($P \leq 0.01$) throughout the grazing season. The decrease in selection of BFT by heifers from BFT /TF pasture in summer may be attributed to decreased percentage of BFT as well as reduced forage quality.

Key Words: Selectivity, Birdsfoot trefoil, Grazing

249 Effect of grazing system on performance of cow-calf pairs grazing bermudagrass pastures interseeded with wheat and legumes. L.W. Lomas*, J.L. Moyer, G.A. Milliken, and K.P. Coffey, *Kansas State University, Parsons.*

Performance of fall-calving cows and calves grazing bermudagrass pastures interseeded with wheat, red clover, ladino clover, and lespedeza managed as continuous or rotationally grazed systems were evaluated in 1996, 1997, and 1998. Four 4.04 ha "Hardie" bermudagrass pastures were used in a completely randomized block design with two replications per grazing system. Eight cows were randomly allotted to each pasture on May 21, 1996 and 8 cow-calf pairs were randomly assigned to each pasture on March 21, 1997 and April 7, 1998. Rotationally grazed units were subdivided into eight paddocks that were grazed for 3.5-day (1996 and 1998) or 2-day intervals (1997). Cows and calves in 1997 and 1998 initially grazed hard red winter wheat for 56 days, calves were then removed from the pastures, and cows grazed bermudagrass interseeded with legumes for the remainder of the summer. Wheat was not available for grazing in 1996, due to below normal precipitation and grazing was initiated with cows at the beginning of the bermudagrass-legume phase. Cows grazed bermudagrass interseeded with legumes for 113, 88, and 91 days in 1996, 1997, and 1998. Legume cover, available forage dry matter, gains of cows and calves grazing wheat, and gains of cows grazing bermudagrass interseeded with legumes were measured. During 1996, 1997, and 1998, legume cover averaged 7%, 7%, and 9% and available forage averaged 4380, 3510, and 3840 kg/ha. While average legume cover and forage availability did not differ ($P > .05$) between grazing systems, significant ($P < .05$) differences occurred at various times during the season. There were no significant ($P > .05$) year by treatment interactions observed for grazing performance. Although there were significant ($P < .05$) differences in cattle weights between years, cow and calf gains were similar ($P > .05$) between years. Initial cow and calf weights at the beginning of the wheat phase were 610 and 231 kg. Initial cow weight at the beginning of the bermudagrass-legume phase was 592 kg. Grazing system had no effect ($P > .05$) on gains of cows and calves grazing wheat or gains of cows grazing bermudagrass interseeded with legumes. Gains of calves grazing wheat, cows grazing wheat, and cows grazing bermudagrass interseeded with legumes were 1.26, .59, and .74 kg/day.

Key Words: Grazing Systems, Bermudagrass, Legumes

250 First limiting nutrient for lactating beef cows fed grass hay. A. M. Encinias*, H. B. Encinias, G. P. Lardy, D. Jackson, and J. S. Caton, *North Dakota State University, Fargo, ND.*

First limiting nutrient for lactating, spring calving beef cows fed grass hay was examined in a 60-d supplementation trial. Thirty-six British cross-bred cows (630 29 kg initial BW) were fed individually in electronic headgates. Grass hay (9.9% CP) was offered ad libitum, and intake was measured daily. Cows were stratified by weight and age, and assigned randomly to one of four treatments: 1) non-supplemented control (CON), 2) energy control (ENG; .79 kg·d⁻¹; 100% beet pulp), 3) degradable intake protein (DIP; .87 kg·d⁻¹; 22% beet pulp and 78% sunflower meal), or 4) DIP + undegradable intake protein (DIP + UIP; .80 kg·d⁻¹; 62.5% sunflower meal, 30% hydrolyzed feather meal, and 7.5% bloodmeal). Net energy levels were similar (1.36 Mcal·d⁻¹) among supplemented treatments. The DIP and DIP + UIP supplements supplied similar amounts of DIP (178 g·d⁻¹) and supplied 64 and 250 g·d⁻¹ of UIP, respectively. Milk production was measured using a milking machine three times during the trial. Dry matter intake was not affected by treatment ($P > .05$). Treatments did not affect cow body weight or condition score ($P > .10$). Milk production was not influenced by supplementation ($P > .05$; avg 6.6 1.3 kg·d⁻¹); however, percentage of milk fat was greater in supplemented vs non-supplemented treatments and greater for DIP + UIP compared with DIP ($P < .05$). No other differences ($P > .05$) were noted in milk components. During supplementation, calves nursing DIP + UIP supplemented dams tended ($P = .14$) to gain more weight than other treatments. Weaning weights of calves were not different ($P > .10$). Results of this study indicate that supplementation influences milk fat composition, which may influence calf performance.

Item	Treatment				SEM
	CON	ENG	DIP	DIP+UIP	
Forage + Supplement					
DMI, % BW	2.67	2.40	2.53	2.64	.12
			—kg—		
Cow BW gain	-63.4	-50.9	-49.2	-31.8	5.5
Calf BW gain	27.7	28.2	32.7	35.2	9.2
Weaning weight	191.9	198.3	191.0	215.7	11.9

Key Words: Undegradable Intake Protein, Cow Performance, Supplementation

253 Effect of starch, fiber, or degradable intake protein (DIP) supplementation on utilization of fescue hay by heifers. M. L. Linville*, K. C. Olson, and J. N. Spain, *University of Missouri, Columbia.*

Holstein heifers (n = 20; BW = 270 kg) were used in three randomized complete block experiments to determine the effects of various supplements on utilization of low-quality fescue hay. Heifers were restrained in individual tie-stalls and fed fescue hay (*Festuca arundinacea* Shreb.; 7.4% CP, 46.5% ADF) ad libitum. In trial 1, heifers were fed supplemental DIP at 0, .05, .10, .15, or .20% BW/d. Soybean meal (49.9% CP, DIP = 65% of CP) was used to deliver DIP. Forage DM intake (DMI) was unaffected ($P > .05$) by level of supplemental DIP. Total tract DM digestion (DMD) by supplemented heifers was greater ($P < .01$) than by control heifers; moreover, DMD increased linearly ($P < .01$) with supplemental DIP. Digestible DM intake (DDMI) increased quadratically ($P = .02$) in response to increasing supplemental DIP. In trial 2, heifers were fed supplemental NDF at rates of 0, .16, .33, .49, or .65% BW/d. Soybean hulls (66.3% NDF) were used to deliver supplemental NDF. Forage DMI tended to decrease linearly ($P = .08$) as supplemental NDF increased. Total tract DMD increased quadratically ($P = .01$) as supplemental NDF increased, whereas DDMI increased linearly ($P < .01$). Unsupplemented heifers had lower ($P < .01$) DMD and DDMI than supplemented heifers. In trial 3, heifers were fed supplemental ruminally-degradable starch (RDS) at rates of 0, .10, .20, .30, or .40% BW. Dry-rolled corn (72% starch, 75% ruminally degradable) was used to deliver supplemental RDS. Unsupplemented heifers had greater ($P = .02$) forage DMI compared with supplemented heifers; moreover, forage DMI decreased linearly ($P = .03$) with increasing RDS. Unsupplemented heifers had lower DDMI ($P < .01$) than supplemented heifers; moreover, DDMI increased linearly ($P < .01$) as supplemental RDS increased. Total tract DMD increased linearly ($P < .01$) with supplemental RDS and was greater ($P < .01$) among supplemented than unsupplemented heifers. Supplemental DIP, NDF, and RDS improved DDMI by heifers consuming fescue hay; however, supplemental RDS reduced forage DMI.

Key Words: Supplementation, digestion, intake

258 High moisture and dry high oil corn for finishing feedlot steers. W.M. Cerkoney*¹, T.L. Mader¹, and F.N. Owens², ¹University of Nebraska, Concord, NE/USA, ²Optimum Quality Grains, L.L.C., Des Moines, IA/USA.

British x continental cross yearling steers (36 pens, 10 steers/pen) were used to evaluate the replacement of normal (N) corn with high oil (HO) corn in finishing diets. Finishing diets were 84% corn on DMB, which contained equal quantities of DM from dry rolled corn (D) and high moisture corn (HM). For HM storage, both HO and N corn were harvested at 28% moisture, rolled and stored in bunker silos. Fat content of ND, NHM, HOD, and HOHM corn was 4.5%, 5.0%, 7.0%, and 8.1% of DM with N corn having a higher fat content than expected. Fermented HO corn contained more ($P < .10$) lactate than fermented N corn. Treatment groups were; ND and NHM (1), HOD and HOHM (2), HOD and NHM (3) and ND and HOHM (4). Dry matter intake for the feeding trial was 11.85, 11.59, 11.49, and 11.81 kg/d, respectively. Treatments 1 and 4 had a higher ($P < .10$) DMI than treatment 3. Statistical contrasts included the effect of corn source fed as treatment 2 and 4 vs treatment 1 and 3; treatment 2 and 3 vs treatment 1 and 4; and the interaction. Steers fed HOD corn had a 2.5% reduction ($P < .05$) in DMI and 4.2% higher ($P < .05$) gain/feed (G/F) than steers fed ND corn. No ($P > .10$) differences were detected in final weight, ADG, hot carcass weight, dressing percent, liver abscess score, rib fat, marbling score, or yield grade. Steers fed HOHM corn had a larger ($P < .05$) ribeye area

and a higher ($P < .05$) percent kidney, pelvic and heart fat than steers fed NHM corn. Total fatty acid content, of subcutaneous fat, content was higher ($P < .05$) in fat samples for steers fed 2 and 3 than 1 and 4, meat samples did not ($P > .10$) differ. Feeding HO corn in a dry form reduced DMI and improved G/F. However, replacing normal HM corn with high oil HM corn did not significantly alter steer performance or enhance carcass quality.

Key Words: High Oil Corn, Feedlot, Steers

259 Efficacy of an enzyme/live yeast culture product with and without monensin/tylosin in high grain diets for yearling steers. R.A. Dvorak*, *Alltech Inc., Nicholasville, KY, USA.*

One hundred eighty crossbred steers (418 kg) were allotted to 12 outdoor pens with partial shade to determine if a direct fed enzyme/live yeast (Yea-Sacc¹⁰²⁶) product (EYS) and/or monensin/tylosin (M/T) affected feedlot performance. Cattle were placed into pens based on weight and genetic background. Treatments were assigned to pens in a randomized complete block design with treatments arranged in a 2x2 factorial structure. Each treatment was replicated by three pens of cattle. No interactions were detected in the overall 83 day performance data. No differences were observed in 83 day feedlot performance due to M/T or EYS ($P > .10$). However, the initial 28 day data revealed that steers fed the EYS product gained faster ($P < .10$) and consumed more dry matter ($P < .01$) than those fed diets without the product (Table 1). This study indicated that EYS and M/T acted independently and that EYS improves cattle performance during the first 28 days in the feedlot.

	No EYS	EYS	No M/T	M/T
Days 0-28				
Average daily gain, kg	1.34 ^a	1.48 ^b	1.40	1.40
Dry matter intake, kg/d	9.62 ^c	10.03 ^d	10.01 ^c	9.63 ^f
Feed:gain	7.27	6.82	7.16	6.93
Days 0-83				
Average daily gain, kg	1.64	1.69	1.67	1.67
Dry matter intake, kg/d	10.45	10.72	10.67	10.50
Feed:gain	6.36	6.35	6.39	6.31

^{a,b}EYS effect ($P < .10$); ^{c,d}EYS effect ($P < .01$); ^{e,f}M/T effect ($P < .01$).

Key Words: Feedlot, Yeast culture, Monensin

260 Effects of Bovamine™ Rumens Culture on the performance and carcass characteristics of feedlot steers. S.R. Rust¹, K. Metz¹, and D.R. Ware², ¹Michigan State University, ²Nutrition Physiology Corporation.

A study was conducted to evaluate the effects of feeding different combinations of lactic acid-producing and propionic acid-producing bacteria to cattle fed high concentrate diets. Three hundred-twenty crossbred steers were blocked into 10 weight blocks of four pens each with 8 animals per pen. Four dietary treatments were randomly allocated within each weight block. The four dietary treatments included: TRT 1, water only, no bacteria; TRT 2, 1×10^9 cfu*hd⁻¹*d⁻¹ of Propionibacterium freudenreichi (PF24) and 1×10^6 cfu*hd⁻¹*d⁻¹ of Lactobacillus acidophilus (LA45); TRT 3, 1×10^9 cfu*hd⁻¹*d⁻¹ of Propionibacterium freudenreichi (PF24), 1×10^6 cfu*hd⁻¹*d⁻¹ for each of two strains of Lactobacillus acidophilus (LA45 and LA51) and; TRT 4, 1×10^9 cfu*hd⁻¹*d⁻¹ of Propionibacterium freudenreichi (PF24), 1×10^8 cfu*hd⁻¹*d⁻¹ for each of two strains of Lactobacillus acidophilus strains (LA45 and LA51). Each microbial treatment was prepared daily from a freeze-dried preparation by reconstitution into 1000 mL of tap water. The final diet included 43.4% cracked corn, 43.4% rolled wheat, 8% corn silage, and 5.2% protein-mineral supplement. Cattle fed the three direct-fed microbial treatments gained 6.9% faster ($P < .02$) than steers receiving TRT 1. Cattle fed the treatments containing PAB and the lower doses of LAB (TRT 2 and 3) tended to gain more weight ($P = .12$) during the first 28 d on feed as compared to the other treatments. Dry matter intakes were similar among treatments over the 115 d study, however, during the last 58 d, cattle receiving the TRT 4 tended to consume more feed ($P < .11$). Dry matter intakes during the first 28 d were numerically (3.9%) lower for cattle receiving the direct-fed microbial treatments than TRT 1. Feed conversion efficiency was improved by 7.3% ($P < .02$) for cattle fed the TRT 2 and 3 as compared to TRT 1. In summary, the

direct-fed microbials fed in this study improved ADG by 6 to 7% which resulted in a similar level of improvement in feed conversion efficiency.

Key Words: Propionic Acid, Probiotic, Direct-fed Microbial

261 Evaluation of carbohydrate supplementation for beef steers grazing summer tall fescue. L. J. Driedger*, E. S. Vanzant, B. T. Larson, I. Carrasco, and F. Humeau, *University of Kentucky, Lexington.*

Twelve ruminally fistulated, crossbred, beef steers (avg BW = 248 kg) grazing tall fescue in late June were blocked by weight and randomly assigned to control (C), fiber (F), and starch (S) treatments. Steers on C received no supplement, and F and S received hydrogen peroxide-treated oat fiber (Snowite[®], Canadian Harvest) or corn starch (Cargill) at 0.75% BW via rumen fistula daily (0700 h). Adaptation (d1 - 14) was followed by ruminal evacuation and masticate sampling (d15 - 18), total fecal collection (d19 - 23), and Co:EDTA dosing and ruminal fluid sampling (d 26 at 0700, 1000, 1300, 1600, 1900 h; d 27 at 0700 h) for pH, and ammonia analysis. Indigestible ADF was used as a marker for passage rate, digestibility, and intake calculations. Masticate concentrations of CP (9.1%), DIP (74.1% of CP, estimated by enzymatic assay), ADF (30.5%) and ADL (4.0%) were unaffected ($P > .10$) by treatment but OM and NDF concentrations were greatest for S ($P < .10$; 86.8, 87.3, 88.2% OM; 59.0, 58.6, and 61.4% NDF for C, F, and S). Fecal output (1.0, 1.1, and 0.9% BW), forage DMI (2.7, 2.4, and 1.9% BW), total DMI (2.7, 3.2, and 2.6% BW), digestible DMI (1.7, 2.1, and 1.7% BW), forage DMD (62.2, 57.8, and 52.4%), total DMD (62.2, 66.3, and 64.1%), ruminal fill of DM (2.8, 2.2, and 2.4% BW) and liquid (19.2, 16.0, and 16.1% BW), liquid dilution rates (10.6, 12.2, and 12.6 %/h), and IADF passage rates (2.6, 2.6, and 2.4 %/h) were unaffected ($P > .10$) by treatment, although treatment tended to affect forage intake ($P = .17$) and digestibility ($P = .12$). Ruminal pH was lowest ($P < .10$) for S, and highest for C (6.62, 6.54, and 6.35 for C, F, and S). Ruminal ammonia concentration was greater ($P < .10$) for C than for F or S (5.71, 1.66, and 1.01 mM). Trends for forage intake and digestibility and shifts in ruminal pH suggest that forage use may be enhanced with fiber, as compared with starch supplementation. Changes in ruminal ammonia concentrations indicate the possibility of increasing N capture through the use of energy supplementation.

Key Words: Grazing, Fescue, Carbohydrate source

262 Effect of trenbolone acetate on production of steers grazing spring fescue. K. P. Coffey*, W. K. Coblenz, E. L. Piper, C. F. Rosenkrans, Jr., D. S. Hubbell, III, K. F. Harrison, T. M. Denard, F. W. Pohlman, D. H. Hellwig, and L. J. McBeth, *University of Arkansas, Fayetteville.*

A 64-d grazing study was conducted with a 2 x 2 factorial treatment arrangement to evaluate the impact of implant treatment on performance, hair score, and serum prolactin level of steers grazing high (HE) or low (LE) endophyte-infected tall fescue pastures. Mixed-breed steers ($n=130$; 246 ± 3.5 kg) were allocated randomly to one of three 4-ha HE or one of four 4-ha LE pastures beginning April 13. Within each replication, half of the steers were implanted (I) with trenbolone acetate (40 mg) and estradiol (8 mg) and half were not implanted (NI). Steers were offered a commercial mineral but no other supplemental feed. No implant treatment by endophyte level interactions were detected ($P > .10$). Overall gains were greater ($P < .05$) from I vs. NI (45.1 vs. 39.3 kg) but serum prolactin concentrations and hair scores on either d 36 or 64 did not differ ($P > .10$) between I and NI. Steers grazing HE had lower ($P < .01$) total gain (34.4 vs. 50.0 kg), inferior ($P < .05$) hair scores, and lower ($P < .01$) serum prolactin concentrations (8.8 vs. 404.4 ng/ml) at the end of the study than those grazing LE. Across forage and implant treatments, overall animal gains were negatively correlated with hair scores measured on d 64 ($r = -.28$; $P < .01$), and positively correlated with serum prolactin concentrations measured on d 36 and 64 ($r = .33$ and $.43$, respectively; $P < .01$). Within HE steers, steer gains tended ($P < .10$) to be correlated ($r = .25$) with serum prolactin concentrations measured on d 64. Within LE steers, animal gains tended ($P < .10$) to be negatively correlated ($r = -.23$) with hair scores measured on d 36. Therefore, fescue toxicity symptoms were manifested in HE steers, and implanting with trenbolone acetate and estradiol improved grazing weight gain, but no endophyte level by implant treatment interactions

were found. Implanting steers with trenbolone acetate and estradiol did not reduce the toxic effects of fescue in this study.

Key Words: Fescue Toxicity, Trenbolone Acetate, Cattle

263 Dry or high moisture high oil corn for finishing feedlot steers. F. N. Owens^{*1}, S. D. Soderlund¹, M. A. Hinds¹, D. W. Rice¹, and S. K. Duckett², ¹*Optimum Quality Grains, L.L.C., Des Moines, IA.*, ²*University of Idaho, Moscow, ID.*

Eighty Angus and angus-crossbred steer calves (399 kg) were fed individually (Calan gates) for 112 days. Calculated to provide 1.34 Mcal NEg/kg, diets contained (DM basis) 78% grain (either typical corn – Pioneer 3335 or high oil corn grain – Pioneer 32R90), 7.5% alfalfa silage, 7.5% alfalfa hay, and 7% supplement. Dry rolled grains analyzed 87.6, 8.3, 3.8; 87.8, 9.1, 7.5% while ensiled grains analyzed 76.2, 9.9, 4.8; 75.1, 11.4, 10.1% DM, CP, and ether extract, respectively. Recovery of rolled ensiled DM stored in two-ton concrete silos (N = 20) averaged 97.3 for high oil and 97.5% for typical grain. Ensiled high oil grain had a higher (P < .02) pH (4.7 vs 4.4) and more (P < .01) acetate but less (P < .03) lactate and soluble N than ensiled typical grain. Compared with steers fed dry rolled corn, steers fed high moisture grain consumed 3% less (P < .08) DM, gained 4.7% less (P < .10), and yielded longissimus steaks with less (P < .05) desirable taste panel attributes (juiciness, tenderness, flavor) as well as a higher (P < .09) incidence of off flavors and greater (P < .02) rancidity. Compared to steers fed 3335, steers fed high oil corn consumed slightly more feed (2%), had 6.4% greater (P < .03) ADG (when adjusted to a constant dressing percentage), 4.3% greater (P < .06) gain/feed, and reduced (P < .01) detectable connective tissue in longissimus steaks aged 14 days. Though no interactions were detected, the net energy advantage for high oil corn over typical corn tended to be greater when corn was dry rolled (4.8%) than when it was ensiled (1.9%) prior to feeding.

Item	Dry HOC	Dry Typical	Ensiled HOC	Ensiled Typical	Grain H ₂ O	Oil level
ADG,						
carcass adj.	1.79	1.66	1.68	1.61	P = .10	P = .03
DMI	10.81	10.58	10.47	10.31	P = .08	P = .26
G/F,						
carcass adj.	.166	.157	.161	.156	P = .45	P = .06
Diet NEg,						
kcal/g	1.40	1.34	1.37	1.35	P = .76	P = .12
Grain NEg,						
kcal/g	1.57	1.50	1.54	1.51	P = .76	P = .13

Key Words: High oil corn, Feedlot, Steers

264 Effects of implanting and explanting on performance of finishing steers. B.A. Berry^{*1}, D.R. Gill¹, F.N. Owens¹, R.L. Ball¹, B. Freking², and B.A. Gardner¹, ¹*Oklahoma State University, Stillwater, OK.*, ²*Kerr Foundation, Poteau, OK.*

Angus-Senepol crossbred steers (n=125; BW 332 kg ± 34) that had never been implanted were blocked into five weight blocks, 5 pens in each weight block (5 steers per pen), and randomly assigned to 5 implant schemes for a 134 d finishing trial. Steers in the first group received no growth-stimulating implants throughout the trial. All steers in the remaining four treatments received a combination estradiol/trenbolone acetate implant (24.0 mg and 120.0 mg) at the beginning of the trial. During the first 84 days of the trial, ADG was 25% greater (P < .0001) and feed to gain was 9.8% better (P < .0001) for implanted steers. On d 84 of the trial, steers in treatments 2 and 3 received a second implant; however, the first implant was removed (explanted) from steers on treatment 3. Treatments 4 and 5 received no terminal implant; but steers in treatment 4 were explanted on d 84. From d 85 to 134, the period following reimplanting and explanting, ADG remained lower (P < .006) for nonimplanted steers than for steers on all other treatments except for steers that were explanted without replacement on day 84. Explanting at day 84 decreased (P < .0008) ADG by .34 kg and increased feed to gain ratio by 34.2% (P < .0001) compared to cattle implanted only once. Steers that were explanted and reimplanted had greater (P < .007) ADG than cattle that were explanted but gains were not different than those of steers that received a single implant initially. Steers that had stacked implants had greater ADG (P < .02) than all other steers except those that received a single implant at the beginning of the study.

Performance responses to explanting and to implant replacement indicate that payout time of these implants exceeded 134 days. However, the ADG response to stacking implants (19% above mere replacement) implies that benefits from reimplanting must be attributed to hormonal dose level, not to hormone depletion. If the hormonal dose in an initial implant is inadequate to maximize performance, reimplanting will prove beneficial.

Key Words: Beef, Explant, Performance

265 Impact of implants and monensin on weight of steers fed at maintenance. B.A. Gardner^{*1}, F.N. Owens², J.T. Wagner¹, R. Ball¹, and D.R. Gill¹, ¹*Oklahoma State University, Stillwater.*, ²*Optimum Quality Grains, LLC, Des Moines.*

Steer calves (n=192; 293 kg) were limit-fed a 50% concentrate diet (NEm=1.76 Mcal/kg DM) at their estimated maintenance requirement (3.27 kg DM daily) for 56 d. Steers, stratified by weight, were assigned randomly to one of 32 pens (six/pen) with eight pens assigned to each of four implant regimes: none, 14 mg estradiol 17β, 140 mg trenbolone acetate (TBA), or 14 mg estradiol 17β plus 140 mg trenbolone acetate. Within each implant regimen, four pens of steers were fed diets with no monensin; other pens received 33 ppm added monensin. Feed supply was adjusted weekly to achieve zero weight gain. Steers receiving TBA alone or in combination with estrogen had greater (P < .05) weight gain by d 7; this difference was maintained throughout the trial. A favorable response (P < .04) in weight retention to estrogen first became evident on d 28. By d 56, control steers had gained 8.89 kg (ADG = .16 kg); TBA implanted steers gained 10.21 kg (P < .001) more and estrogen implanted steers gained 3.45 kg more (P < .03) weight than control steers. Effects of TBA and estrogen implants appeared additive. For steers fed diets containing monensin, a weight gain advantage was detected (P < .06) starting on d 21; by d 56, steers receiving monensin gained 3.27 kg more weight (P < .04) than steers not receiving monensin. Response to monensin tended to be greater for implanted than nonimplanted steers. Ultrasound fat thickness (1.88 mm) at d 56 was not (P = .64) altered by implant regimen or diet. Mean hip height increased 3.2 cm during the trial, but treatment differences were not (P = .39) significant. Results indicate that weight of steers limited in energy intake can be increased by including monensin in the diet and by administering estrogenic or TBA implants. Based on net energy calculations, the amount of feed required for weight maintenance of these immature steers was reduced 4.4% by feeding monensin, 4.3% with an estrogen implant, 13.1% with a TBA implant, and 18.1% with a combination implant.

Key Words: Implants, Ionophores, Maintenance

266 Effects of non-protein nitrogen source in blocks supplemented to cattle fed prairie hay. C. A. Loest^{*}, E. C. Titgemeyer, J. S. Drouillard, B. D. Lambert, and A. M. Trater, *Kansas State University, Manhattan.*

Eighteen steers (268 kg) were used in an intake and digestion study (Exp. 1), and six ruminally cannulated steers (459 kg) were used in a ruminal parameter study (Exp. 2) to evaluate source of non-protein N in cooked molasses blocks supplemented to cattle fed prairie hay (5.5% CP, 70% NDF) *ad libitum*. Treatments for Exp. 1 were 1) control (C; no block), 2) 60% CP block with 83% of the CP from urea (U), and 3) 60% CP block with 42% of the CP from urea and 42% from biuret (U/B). Treatments for Exp. 2 were U and U/B. Blocks were fed once daily at .125% BW as small pieces for rapid consumption. Exp. 1 was 21 d with 15 d for adaptation. In Exp. 2, ruminal NH₃ was measured 3, 7, 14, and 21 d after initiation of treatments at 0, 1, 2, 4, 6, 8, 12, and 16 h after feeding blocks. Forage OM (4.34, 5.34, and 5.25 kg/d for C, U, and U/B), NDF (3.28, 4.04, and 3.99 kg/d for C, U, and U/B), and CP (.265, .324, and .318 kg/d for C, U, and U/B) intakes tended to be increased (P<.08), and digestible OM (2.25, 3.50, and 3.34 kg/d for C, U, and U/B), NDF (1.60, 2.41, and 2.30 kg/d for C, U, and U/B), and CP (.090, .287, and .257 kg/d for C, U, and U/B) intakes were increased (P<.01) by blocks. Total tract OM (52.2, 62.7, and 60.7% for C, U, and U/B), NDF (49.4, 60.0, and 58.0% for C, U, and U/B), and CP (33.6, 55.1, and 50.8% for C, U, and U/B) digestibilities were increased (P<.01) by blocks. Intakes and digestibilities were similar for U and U/B except digestible CP intakes were greater (P<.05) for U than U/B. Averaged over time, ruminal NH₃ was greater (P<.05) for U (15.1 mM) than U/B (10.0 mM) due to higher ruminal NH₃ at 2, 4, and 6 h after feeding blocks (45.0, 22.6, and 12.3 mM for U and 24.5, 12.2, and 6.3 mM for U/B at 2, 4, and 6 h). Supplementation with cooked molasses blocks containing high levels of non-protein N increased intake

and digestion of prairie hay, but replacing half of the urea with biuret had little effect.

Key Words: Cooked molasses blocks, Urea, Biuret

267 In situ fiber digestibility responses to feed intake and ruminal pH. M Basalan*¹ and F. N. Owens², ¹Oklahoma State University, Stillwater, OK, ²Optimum Quality Grains, L.L.C. Des Moines, IA.

When ruminal pH falls below 6.0, fiber fermentation has been presumed to cease due to reduced attachment and activity of cellulolytic bacteria. This study was designed to examine whether various fiber sources and fiber components responded similarly to pH changes when ruminal pH consistently remained below 6.0. Three ruminally fistulated crossbred heifers (434.25 kg) in a 3 by 3 Latin square design were fed a 90% concentrate diet three times daily; DMI were .9%, 1.4% BW/d, and free choice. Forages tested included the NDF residues obtained from corn silage (separated into grain and non-grain [stover] portions), cottonseed hulls (CSH), and wheat pasture (12.6%, 69.4%, 86.6% and 61.8% NDF content and 4.7%, 37.6%, 54.8% and 24.1% ADF content, respectively). NDF residues from these feeds, isolated from these feeds in these dacron bags, were suspended within rumen for 0, 6, 12, 24, and 96 h; pH was monitored every fourth hour. Residues were analyzed and disappearance of NDF, ADF, and hemicellulose (NDF minus ADF) was calculated. Ruminal pH (range = 4.3 to 5.9) was lower with the highest feed intake (4.9 vs 5.3 and 5.5 for free choice, 0.9, and 1.4% BW/d dry matter intakes). For corn stover and wheat pasture, disappearance of NDF and hemicellulose were lowest with the lowest feed intake. Extent of disappearance was highest ($P < .05$) for wheat pasture at all incubation times. NDF disappearance at 24 h was 2.4, 4.6, 12.2, and 29.5% for stover, CSH, grain, and wheat pasture while ADF disappearance was very low (1, 3, 6, and 10%). Regressed against pH and pH squared, disappearance of NDF, ADF, and hemicellulose at 96 h all increased ($P < .05$) as pH increased. At 24 h, disappearance of NDF and hemicellulose also increased with pH (except for stover). At 12 h, NDF and ADF disappearance increased with pH for cottonseed hulls but decreased with pH for corn stover. Even though pH remained below 5.9, extent of in situ disappearance of NDF and hemicellulose at 24 and 96 h consistently increased as ruminal pH increased.

Key Words: Fiber Digestion, Rumen, pH

268 Effects of alfalfa leaf meal on feedlot performance and incidence of liver abscesses. D. Standorf*¹, A. DiCostanzo¹, G.C. Lamb², L.J. Smith³, and A. Miron⁴, ¹University of Minnesota, St. Paul, ²North Central Research and Outreach Center, Grand Rapids, MN, ³Northwest Research and Outreach Center, Crookston, MN, ⁴Land O Lakes/Harvest States Feed, Sioux Falls, SD.

We demonstrated that alfalfa leaf meal (ALM) is a suitable protein source in finishing cattle diets. Additionally, feeding ALM as the sole supplemental protein source reduced liver abscess incidence. The current study was undertaken to evaluate effects of protein source (ALM vs. vegetable protein blend) or ionophore (Rumensin or Cattlyst) on feedlot performance, carcass characteristics and incidence of liver abscesses. Two hundred fourteen Angus crossbred steers (273 kg) were stratified by weight and origin into 16 pens for a 167-d finishing trial. Pens were randomly assigned to one of four treatments resulting from the factorial arrangement of protein or ionophore type. Diets were formulated to contain 1.34 Mcal/kg DM, 12.5% CP, .6% Ca, and .25% P. Steers were implanted with Revalor-S on day 1 and on day 86. No significant interaction ($P > .05$) was observed between ionophore and protein type. Neither protein source nor ionophore ($P > .05$) affected feedlot performance or carcass characteristics. Average daily gain, DMI and DM required/kg gain were 1.86 kg/d, 9.16 kg/d, and 4.92 kg, respectively. Results were not conclusive with regards to effects of ALM on incidence of liver abscess. Steers supplemented with ALM and Cattlyst had a 13.2% incidence while steers supplemented with the blend and Cattlyst had a 38.8% incidence ($P < .05$). This was similar to results of previous research. However, 31.5% of livers from steers supplemented with ALM and Rumensin had liver abscesses while only 9.6% of livers from steers supplemented with the blend and Rumensin had liver abscesses ($P < .05$). The reason for this interaction is unclear and suggests that additional research be conducted to define the mechanism by which ALM reduces incidence of liver abscess in the presence of laidlomycin propionate.

Key Words: Alfalfa, Steers, Liver abscess

269 Alfalfa hay levels in limit-fed, high-energy growing diets for beef steers. S. P. Montgomery*, J. S. Drouillard, J. J. Sindt, T. B. Farran, H. J. LaBrune, R. D. Hunter, J. J. Higgins, and T. A. Nutsch, Kansas State University, Manhattan.

One hundred and sixty four crossbred beef steers (262 kg) were used in a randomized complete block design to determine optimum levels of alfalfa in limit-fed, high-energy growing diets containing steam flaked corn and wet corn gluten feed. Steers were fed a common diet ad libitum for 14 d preceding the growing phase to minimize differences in gastrointestinal tract fill. Steers were allotted to pens containing five to seven animals with nine pens per treatment. Treatments consisted of diets containing steam flaked corn and wet corn gluten feed (40% DM) with 0, 10, or 20% ground alfalfa hay (0ALF, 10ALF, and 20ALF). A fourth diet containing 20% ground alfalfa hay and steam flaked corn was used as a control (CONTROL). All diets contained 33 mg/kg of monensin and were fed once daily at 1.8% of body weight for 88 d. Prior to obtaining final weights for the growing phase, cattle were fed a common diet ad libitum for 14 d. ADG for the 102-d growing phase were 1.32, 1.24, 1.22, and 1.25 .05 kg/d and gain efficiencies were .233, .218, .215, and .216 .004 kg gain/kg DM for 0ALF, 10ALF, 20ALF, and CONTROL, respectively. ADG and gain efficiency were greater for 0ALF ($P < .04$ and $P < .02$, respectively) than for 10ALF, 20ALF, or CONTROL. At the end of growing phase steers were placed onto a common finishing diet, fed for 101 d, and then slaughtered. The final finishing diet contained 82% steam flaked corn, 7% ground alfalfa hay, 33 mg/kg monensin, and 11 mg/kg of tylosin and was fed once daily ad libitum. Finishing ADG were 1.42, 1.42, 1.48, and 1.43 .07 kg/d and gain efficiencies were .156, .154, .160, and .152 .003 kg gain/kg DM for 0ALF, 10ALF, 20ALF, and CONTROL, respectively. Finishing ADG and gain efficiencies were not different ($P > .40$ and $P > .15$, respectively) among treatments. Additional roughage may not be required for beef steers limit-fed, high-energy growing diets containing 40% wet corn gluten feed.

Key Words: Wet corn gluten feed, Roughage, Limit feeding

270 Effects of vitamin E supplementation on performance and health of newly received feedlot cattle. J. Carter*, D. Gill, and A. Confer, Oklahoma State University, Stillwater, Oklahoma.

Four truckloads (247 heifers, 231 kg \pm 16; 130 bulls and steers, 151 kg \pm 10) were fed a common receiving diet (14.8% CP) ad libitum for 42 days. The diet consisted of soybean hulls, whole shelled corn, wheat midds, cottonseed hulls, and a protein supplement containing lasalocid. An additional pelleted supplement was manufactured from wheat midds and a commercially available source of dl- α -tocopheryl acetate, and incorporated into the diet to provide 2000 I.U. of vitamin E daily for 0, 7, 14, or 28 days at decreasing rates as dry matter intake increased (2.0 kg DMI=6%; 4.0 kg DMI=4%; 6.0 kg DMI=2%). Our objective was to determine the effects on animal performance and immune response as measured by antibiotic treatment costs within each treatment. Upon arrival, a shrunk weight was obtained and cattle were allocated to one of two weight blocks (light and heavy) and to one of the four treatments in a completely randomized block design. Average daily gain was greater ($P < .04$) for the 28-d vs the 14-d treatment (1.0 kg/d vs 0.9 kg/d); however, daily gain was not different ($P > .05$) among the 0-, 7- and 28-d treatments, nor among the 0-, 7- and 14-d applications. Daily gains were improved between the two weight blocks, light and heavy (light=1.0 kg/d vs heavy=0.9 kg/d; $P < .05$). Dry matter intake and feed conversion were not different ($P > .05$) among these four loads of cattle; however, antibiotic treatment costs were different among loads ($P < .04$) attributable to various factors including cattle type and environmental conditions, but there was no advantage among the dietary vitamin E treatments. Results from these four loads of cattle indicate that supplementation with high levels of vitamin E in a receiving diet provides only limited benefits to animal performance and thus far, has not reduced therapeutic treatment costs of newly arrived feedlot cattle. Further research is on-going and may provide more information regarding serum vitamin E concentration and its relationship to immune function.

Key Words: Vitamin E, Immune Response

271 Utilization of Bt corn residue and corn silage for growing beef steers. J. D. Folmer*¹, G. E. Erickson¹, C. T. Milton¹, T. J. Klopfenstein¹, and J. F. Beck², ¹University of Nebraska, Lincoln, NE, ²Novartis Seeds, Golden Valley, MN.

Two trials were completed to evaluate the use of Bt corn hybrids (derived from Event Bt11) for growing steers. Trial 1 utilized fields of N7333 Bt and N7333 non-Bt post-harvest corn residue to evaluate daily gain and grazing preference. The absence of significant European corn borer (ECB) pressure resulted in similar grain yields (184 and 182 bu/acre) and residual corn (1.0 and 1.5 bu/acre) for the Bt and non-Bt hybrid, respectively. Twenty-three acres of Bt and 21 acres of non-Bt corn residue were divided into 3 pastures and stocked with 8 or 9 steers, providing equal stocking rates. Daily gain of 67 steers grazing corn residue for 70 d was similar (avg. 0.28 kg/d). Also, 16 steers allowed access to either 7 acres of Bt or non-Bt corn residue demonstrated no grazing preference. In Trial 2, 128 steers (avg. 282 kg) were fed corn silage diets (90% silage and 10% supplement, DM basis) for 101 d. Treatments were arranged as a 2 x 2 factorial: Bt or non-Bt versions of hybrids N7333 or N4242. Dry matter intake was higher (8.61 vs 8.32 kg/d; $P < 0.05$) for steers fed Bt compared with non-Bt hybrids. An interaction ($P < 0.05$) was observed between hybrid genotype and Bt trait for daily gain and feed efficiency. Daily gain was higher (1.46 vs 1.36 kg/d; $P < 0.05$) for steers fed N4242 Bt compared with N4242 non-Bt. Daily gain was similar (avg. 1.28 kg/d) for steers fed N7333 Bt and non-Bt. Feed efficiency was better ($P < 0.05$) for steers fed N7333 non-Bt (6.33) compared with N7333 Bt (6.81). Feed efficiency was similar (avg. 6.10) for steers fed N4242 Bt and non-Bt. Although an interaction was present, steers fed the N4242 hybrids gained 11% faster ($P < 0.01$) and were 8% more efficient ($P < 0.01$) than those fed the N7333 hybrids. Presence of the Bt trait in corn hybrids had no consistent effect on performance of growing steers, while hybrid genotype appeared to affect performance. Higher ECB pressure may indirectly influence grazing performance on Bt and non-Bt corn residue.

Key Words: Bt corn residue, Bt corn silage, Steers

273 Effects of oscillating dietary protein on visceral organ mass in lambs. T. L. Wechter*, P. A. Ludden, and B. W. Hess, University of Wyoming, Laramie, WY.

Twenty-four wether lambs (avg initial BW = 37.5 ± .8 kg) were used in a 64 d randomized complete block designed experiment to evaluate the effects of oscillating dietary protein on visceral organ mass. Four treatments consisted of either an 11, 13, or 15% CP diet fed daily, or a regimen in which dietary CP was oscillated between 11 and 15% on a 48-h basis (i.e. 11, 11, 15, 15, 11, 11; ACP). All diets consisted of 65% bromegrass hay (9.0% CP, 61% NDF, 37% ADF) plus 35% corn-based supplement, and were formulated to contain 8.5% of DM as DIP using a combination of soybean meal and urea. Treatment CP concentrations above 11% were accomplished with the addition of a UIP source (SoyPLUS[®], West Central Cooperative, Ralston, IA). All wethers were fed at 3.0% of initial BW (DM basis) throughout the trial, resulting in an average DMI of 1.14 kg/d across treatments. Increasing CP linearly decreased ($P < .10$) weights of the reticulorumen, abomasum, and small intestine, but did not affect ($P > .33$) liver or omasum weights. Small intestine length was not affected ($P = .73$) by treatment, but lambs fed 13% CP daily had lower ($P = .10$) small intestine weights than ACP fed lambs. Oscillating dietary CP may have negative effects on visceral organ mass. The potential increase in energetic efficiency associated with decreased visceral organ mass in response to UIP supplementation deserves further investigation.

	11% CP	13% CP	15% CP	ACP	SEM	13 vs Linear	ACP
Empty BW (EBW), kg	29.6	31.1	31.4	30.9	.95	.19	.90
Organ Mass, % of EBW							
Small							
Intestine	2.7	2.2	2.1	2.6	.16	.01	.10
Liver	2.3	2.3	2.3	2.4	.09	.55	.32
Reticulo- rumen	3.0	2.8	2.7	3.0	.13	.09	.28
Abomasum	.7	.5	.5	.5	.05	.02	.75

Key Words: Protein, Visceral organs, Sheep

274 Field pea (*Pisum sativum*) replacement of corn in lamb finishing diets. E. R. Loe*, M. L. Bauer, G. P. Lardy, P. T. Berg, and B. L. Moore, North Dakota State University, Fargo.

One hundred crossbred rams (39.1 .2 kg initial BW) were blocked by weight and allotted randomly to one of five treatments (5 pens/treatment) to evaluate the energy value of field peas. The first four treatments contained 75% corn or peas, 10% alfalfa, 5% concentrated separator by-product, 6% SBM, and 4% supplement. Peas replaced corn at 0, 15, 30, or 45% of the diet. In the fifth treatment (45-no-SBM), peas replaced corn and SBM and contained 45% peas, 36% corn, 10% alfalfa, 5% CSB, and 4% supplement. All diets contained .2% bloodmeal, and .8% feathermeal. Diets were formulated to contain a minimum of 14.8% CP, .7% Ca, .43% P, 1.22% K, 1.51 Ca:P, and 28 mg lasalocid/kg. Data were analyzed using the GLM procedures of SAS and linear, quadratic, and cubic effects of peas were determined. A contrast was used to compare the 45% pea and the 45-no-SBM treatment. Lambs were fed for 63 d. Initial and final weights were an average of two consecutive day weights. Level of peas did not affect ($P > .15$) any measures of performance (DMI, ADG, or feed efficiency). The lambs fed 45-no-SBM diet were more efficient than those fed 45% pea ($P = .10$; .237 vs .217, respectively). Leg score (11.1, 11.5, 11.2, and 11.0, respectively) and conformation score (11.0, 11.4, 11.0, and 10.8, respectively) changed quadratically ($P = .05$) with addition of peas. No other carcass characteristics were affected by treatment ($P > .10$). Dietary NE_m and NE_g were greater for 45-no-SBM vs 45% peas ($P = .05$; 2.43 vs 2.23 .07 Mcal/kg NE_m and 1.72 vs 1.54 .06 Mcal/kg NE_g, respectively). There were no other dietary effects on NE_m or NE_g ($P > .24$). The calculated NE_m and NE_g for field peas were 2.67 and 1.93 Mcal/kg, respectively. Based on lamb performance field peas have an NE_g that is 3% greater than corn and effectively replace corn and SBM in lamb finishing diets.

Key Words: Field Peas, Finishing, Lamb

275 Metabolizable protein level in lamb finishing diets. E. R. Loe*, M. L. Bauer, G. P. Lardy, P. T. Berg, and B. L. Moore, North Dakota State University, Fargo.

Eighty crossbred lambs (39.0 .3 kg initial BW) were blocked by weight and allotted randomly to one of four treatments (5 pens/treatment) to evaluate if metabolizable protein (MP) limited gain in a corn-based finishing diet. Treatments were arranged in a 2 x 2 factorial; with or without added DIP or UIP. Treatments were CON (-DIP; -UIP), D (+DIP; -UIP), U (-DIP; +UIP), and DU (+DIP; +UIP). Corn levels were 75, 71, 74, and 70% for CON, D, U, and DU, respectively. All diets contained 10% alfalfa and 5% concentrated separator by-product. Diets were formulated to contain a minimum of 14.8% CP, .7% Ca, .43% P, 1.22% K, 1.51 Ca:P, and 28 mg lasalocid/kg. Rumen degradable intake protein sources were SBM and urea; whereas, UIP sources were feathermeal and bloodmeal. Main effects of DIP, UIP, and their interactions were tested. Lambs were fed for 63 d. Initial and final weights were an average of two consecutive day weights. Performance measurements were DMI, ADG, and feed efficiency. Lambs eating UIP diets had heavier final weights ($P = .009$), gained more rapidly ($P = .007$), and were more efficient ($P = .07$) compared with lambs eating DIP treatments. There was a DIP x UIP interaction ($P = .08$) for REA where addition of UIP alone increased REA vs CON and D. Dietary NE_m and NE_g were greater ($P = .09$) for diets containing added UIP. Based on lamb response to UIP, MP limited gain and feed efficiency in corn-based finishing diets for lambs gaining .35 kg/d, or greater.

ITEM	Dietary treatment				Effect			
	CON	D	U	DU	SEM	DIP	UIP	DIP × UIP
CP, %	14.8	16.9	16.2	18.2				
DIP, %	8.9	11.0	8.9	11.0				
UIP, %	5.9	5.9	7.3	7.3				
MP:ME, g/Mcal	22.2	22.2	24.5	23.6				
Final Wt., kg	61.3	60.8	64.7	62.8	.9	.20	.009	.44
DMI, kg/d	1.58	1.55	1.68	1.53	.06	.12	.49	.33
ADG, kg/d	.35	.35	.41	.38	.01	.19	.007	.28
FE, g/100 g	22.3	22.6	24.6	25.3	1.3	.71	.07	.87
REA, cm ²	14.9	15.6	16.7	15.7	.4	.73	.04	.08
NE _m , Mcal/kg	2.31	2.34	2.47	2.55	.10	.62	.09	.82
NE _g , Mcal/kg	1.62	1.64	1.76	1.82	.09	.60	.09	.83

Key Words: Lambs, Degradable Protein, Undegradable Protein

276 The effect of dietary energy and protein on feed intake, gain, and nitrogen balance in callipyge and normal genotype lambs. S. N. Al-Dabeeb*, S. L. Nissen, D. G. Morrical, and J. A. Rathmacher, *Iowa State University, Ames.*

The expression of callipyge (CLPG) genotype (GEN) lambs is characterized by heavy muscling and less carcass fat. The objective of this study was to determine interaction between protein and energy intake on performance and nitrogen (N) metabolism in CLPG and normal Dorset crosses lambs. Twelve lambs (36.7±1.6KG) were studied in two blocks (3 CLPG and 3 Normal/Block). Lambs were paired and fed three diets differing in energy and/or protein levels; HEHP (3.1 Mcal ME/kg DM, 15.75% CP), HELP (3.1 Mcal ME/kg DM, 9.5% CP), and LEHP, (2.1 Mcal ME/kg DM, 15.75% CP) in a 3x3 Latin square arrangement of diet treatments. The lamb pairs were fed each diet ad libitum for 3 weeks. During the last 5 days of the period, quantitative urine and feces output were collected. CLPG lambs had similar weight gain compared to normal lambs. Lambs fed HEHP diet gained faster than when fed the HELP and LEHP diets (0.23, 0.14 and 0.09 kg/d, respectively). Diet significantly affected N intake, urinary N, and fecal N output, along with N balance (p<0.05). CLPG lambs retained more N compared to normal lambs when fed HEHP or HELP diets but less N when fed LEHP Diet. Across all diets, CLPG lambs secreted less N in the urine (P< 0.05) compared to normal lambs (13.3 and 15.3 g/d, respectively). In conclusion, these data indicate that N retention is markedly affected by energy intake, but the callipyge lambs attenuated nitrogen retention to a greater extent than normal lambs with reduced energy intake. These data are suggestive of a greater maintenance energy need in callipyge lambs.

	Normal			Callipyge			P-value
	HEHP	HELP	LEHP	HEHP	HELP	LEHP	
N Intake, g/d	24.8	15.2	31.6	25.5	14.8	29.8	0.0002
Urine N, g/d	16.6	6.8	22.1	13.2	5.8	21.0	0.0001
Fecal N, g/d	5.3	5.8	10.4	5.9	4.7	10.3	0.0003
N Balance, g/d	2.5	2.6	-0.87	6.3	4.3	-1.5	0.02

Key Words: Callipyge Lambs, Gain, Nitrogen Balance

277 Ewe and lamb production on smooth bromegrass and alfalfa pastures. W. A. Head, Jr.*, G. J. Cuomo, M. V. Rudstrom, C. C. Sheaffer, and M. H. Reese, *University of Minnesota.*

Alfalfa has the potential to be more widely used in pasture based animal production systems. This is particularly true in areas where cool-season grass pastures are dominant and forage production is low during mid-summer. A 2-year randomized complete block trial with three replications per year was conducted to compare three breeds of sheep (Columbia, East Friesian, and Polypay) for ewe and lamb production on smooth bromegrass and alfalfa pastures. The study was initiated on May 24 and lambs were weaned on August 2 of each year. Lamb average daily gains were similar (P=.11) on bromegrass and alfalfa pastures in early summer prior to June 27 and averaged 0.30 kg·d⁻¹ for lambs

grazing both alfalfa and bromegrass pastures. From June 27 to weaning, lambs had greater gains (P=.04) on alfalfa pastures (0.27 kg·d⁻¹) than on smooth bromegrass pastures (0.20 kg·d⁻¹). Columbia ewes tended to produce more (P<.16) kilograms of lamb per ewe than did the other breeds (42 kg·ewe⁻¹, 38 kg·ewe⁻¹ and 37 kg·ewe⁻¹ for Columbia, East Friesian, and Polypay ewes, respectively). However when using pounds of lamb produced per pound of ewe as a measure of efficiency, Columbia ewes produced numerically (0.53 kg·d⁻¹) less (P>.22) lamb than East Friesian (0.59 kg·d⁻¹) ewes. This indicates that there may be a need to evaluate biological type when using a pasture based production system. Both alfalfa and bromegrass produced positive lamb gains (average ADG=.30 kg·d⁻¹) during mid-and late June in 1997. Alfalfa also provided for greater lamb gains during July (0.27 kg·d⁻¹ and 0.20 kg·d⁻¹, for alfalfa and bromegrass respectively). It appears that alfalfa is well suited for mid-summer grazing and could be used either as a full season pasture crop or as a mid-summer pasture in a forage system that uses cool-season grasses in conjunction with alfalfa pastures.

Key Words: Sheep, Alfalfa, Bromegrass

278 Degradable intake protein requirement of finishing steers fed a steam flaked corn-based diet. R. J. Cooper*, C. T. Milton, T. J. Klopfenstein, and D. J. Jordan, *University of Nebraska, Lincoln, NE.*

A finishing trial was conducted to determine the degradable intake protein (DIP) requirement of steers fed a steam flaked corn-based diet. Two hundred and sixty-four crossbred yearling steers (average initial wt = 355 kg) were used in a completely randomized design. Steers were stratified by initial weight and allotted to one of twenty-four pens (11 steers per pen). Pens were randomly assigned to one of six dietary treatments (4 pens per treatment). Treatments consisted of graded levels of supplemental urea (0, .4, .8, 1.2, 1.6, and 2.0% of diet DM). Based on tabular values, dietary DIP levels were 4.7, 5.8, 7.0, 8.2, 9.3, and 10.5% of diet DM, respectively. Crude protein values were 9.5, 10.6, 11.8, 13.0, 14.1, and 15.3% of diet DM, respectively. The final diet consisted of 82% steam flaked corn, 5% alfalfa hay, 5% cottonseed hulls, 3% molasses, and 5% dry supplement (DM basis). Steam flaked corn was processed in a commercial feedyard (13.2 kg/bushel flake weight) and hauled to the research facility on a weekly basis. Steers were adapted to the final diet in 21 d with 45, 35, 25, and 15% alfalfa hay (DM basis) replacing steam flaked corn for 3, 4, 7, and 7 d, respectively. Steers were implanted with Synovex C on day 1, Revalor S on day 47, and fed for a total of 129 d. Treatment means were separated with linear, quadratic, and cubic contrasts. Dry matter intake responded quadratically (P = .01) with DIP level (10.3, 10.8, 11.1, 11.1, 11.3, and 10.9 kg/d, respectively). Daily gain responded quadratically (P < .01) with DIP level (1.44, 1.74, 2.00, 2.02, and 2.04 kg/d, respectively). Feed/gain also responded quadratically (P < .01) with DIP level (7.09, 6.21, 5.52, 5.52, 5.59, and 5.38, respectively). Results do not support feeding urea levels above .8% of diet DM in a steam flaked corn finishing diet. Using nonlinear analysis of feed/gain and assuming NRC tabular values for degradable protein, the DIP requirement of finishing steers fed a steam flaked corn-based finishing diet was determined to be 7% of diet DM.

Key Words: Degradable Intake Protein, Steers, Feedlot

279 Programmed gain finishing systems in yearling steers fed dry-rolled corn or wet corn gluten feed finishing diets. T. L. Scott*¹, C. T. Milton¹, T. L. Mader², and T. J. Klopfenstein¹, ¹University of Nebraska-Lincoln, ²University of Nebraska Northeast Research and Extension Center, Concord.

Steers (n=160) were stratified by weight and assigned randomly to one of 16 pens (10 hd/pen) with each pen assigned randomly to one of four factorially arranged (2x2) treatments (4 pens/trt). Factors were grain source (dry-rolled corn (DRC) or wet corn gluten feed (WCGF)) and finishing system (ad libitum (AL) feeding or programmed gain (PG)). Cattle on PG were fed to gain 1.36 kg/d (d 1-50) and 1.54 kg/d (d 51-100) and fed AL during d 101-161. Intakes for PG steers were calculated using the net energy equations (NRC, 1996) and were adjusted every 7d. The DRC diet contained 82.4% DRC, 8% forage, 5% supplement, 3% molasses, and 1.6% soybean meal with 35% WCGF replacing soybean meal and DRC in the WCGF diet. During d 1-100, a grain source x finishing system interaction (P<.01) was observed for DMI. The DMI of PG treatments was similar while WCGF increased DMI by 1 kg/d

in AL cattle. No effect of PG or grain source was observed for ADG (avg. of 1.66 kg/d). An interaction due to the magnitude of difference between the PG groups and their AL controls was detected ($P=.03$) for G/F. For d 1-161, an interaction existed ($P=.01$) for DMI similar to that observed during d 1-100. Daily gain was increased ($P<.01$) by feeding WCGF compared to DRC (1.74 vs. 1.63 kg/d, respectively) and was reduced ($P<.01$) by PG (1.79 vs 1.58 kg/d for AL and PG, respectively). An interaction was observed for G/F ($P=.018$) similar to that observed during d 1-100. Cattle on PG were 2.4% more efficient when fed DRC and 11.9% more efficient when fed WCGF compared to AL controls. Feeding WCGF improved carcass weight ($P=.08$) and 12th rib fat ($P=.04$) while PG resulted in reduced carcass weight ($P<.01$), marbling score ($P<.01$), and 12th rib fat ($P=.04$). The PG system lowered ADG and consequently carcass weight in both DRC and WCGF finishing diets; however, improvements in efficiency were 9.5 percentage units greater in WCGF diets compared with DRC.

Key Words: Beef Cattle, Restricted Feeding, Byproducts

280 Effects of feeding whole soybeans on feedlot steer performance and carcass characteristics. E. E. D. Felton* and M. S. Kerley, University of Missouri, Columbia.

A 72d validation study was conducted to determine whether the feeding of whole raw soybeans (WS) would have any detrimental effects on feedlot steer performance. Whole raw soybeans served as a partial or whole replacement for soybean meal (SBM) and partial replacement of corn in a common corn/SBM based feedlot ration. High percentage Angus steers ($n = 96$, initial wt = 414 kg) were blocked by weight (375, 405, 428 & 447 kg) and randomly assigned to one of four dietary treatments. Dietary treatments were 0, 8, 16 and 24% WS (% of dietary DM). In each dietary treatment, WS replaced 0, 33, 67 or 100% of SBM in the diet and 0, 3.6, 7.2 and 10.8% of the dietary corn. All diets were isonitrogenous and contained equal amounts of corn silage, limestone, NaCl, trace-mineral and vitamin premixes, Rumensin® and Tylan®. No treatment differences ($P\geq.05$) were observed in total gain (124 kg), ADG (1.7 kg/d) or final wt (537 kg). Moreover, no treatment differences ($P\geq$) in hot carcass weight (325 kg), quality grade (5.7), tenth rib backfat depth (10.5 mm), ribeye area (79.55 cm²), or yield grade (3.0) were observed. Progression of tenth rib backfat deposition tended ($P=.11$) to increase as the percentage of WS in the diet increased from 0 to 16%, while the 24% WS diet numerically resulted in the lowest tenth rib backfat depth. Progression of rib marbling did not differ ($P\geq.05$) significantly due to treatment. These data suggest that the inclusion of WS into the diet of feedlot steers is possible without detrimental effects on animal performance or carcass characteristics.

Key Words: Soybeans, Cattle, Carcass Quality

281 Effect of an accelerated finishing program on performance and carcass characteristics of early-weaned bulls and steers. J. P. Schoonmaker¹, S. C. Loerch¹, F. L. Fluharty¹, D. M. Wulf², T. B. Turner¹, and S. J. Moeller¹, ¹The Ohio State University, Wooster, OH, ²South Dakota State University, Brookings, SD.

Sixty-three Angus x Simmental calves were allotted to a bull or a steer group based on sire, birth date and birth weight. At an average age of 75 d (5-15-98), calves in the steer group were castrated. Calves were not creep fed prior to weaning. All calves were weaned and weighed at an average age of 115 d (6-24-98) and transported by truck to the OARDC feedlot in Wooster, OH. Performance information and carcass characteristics were measured in 3 phases. Phase 1 was from 6-25-98 to 9-17-98; phase 2 was from 9-18-98 to 12-3-98; phase 3 was from 12-4-98 to slaughter. Calves averaged 115, 200, and 277 d of age on 6-25-98, 9-17-98, and 12-3-98, respectively. Before implantation, four bulls and four steers were selected for serial slaughter and carcass evaluation. Steers were implanted with Synovex-C at an average age of 130 d (7-9-98), Revalor-S at an average age of 200 d (9-17-98) and Revalor-S at an average age of 277 d (12-3-98). Bulls gained 9.7 % faster (1.75 vs 1.60 kg/d; $P < .01$), consumed 25 more kg of DM (521 vs 496 kg; $P = .11$), and were 3.3 % more efficient (.282 vs .273 kg/kg; $P < .10$) than steers in phase 1. However, steers gained 10.5 % faster (1.62 vs 1.46 kg/d; $P < .02$), consumed similar amounts of DM and were 6.5 % more efficient than bulls (.214 vs .201 kg/kg; $P < .06$) in phase 2. Overall, gains and efficiency were similar between bulls and steers; however, bulls consumed

140 more kg of DM ($P < .05$), gained 27 more kg of weight ($P < .05$), increased hip height growth 12.8 % ($P < .07$), increased REA 12.3 % ($P < .03$), and stayed in the feedlot 18 more d ($P < .05$) to achieve a similar amount of backfat at slaughter. Eighty-five % of both bulls and steers graded low choice or better. Placing early-weaned bulls and implanted steers on a high grain diet resulted in excellent feedlot performance and carcass characteristics in cattle marketed before a year of age.

282 Brown Midrib-3 improves fiber digestibility of corn silage diets fed to growing beef steers. K. E. Tjardes*, D. D. Buskirk, M. S. Allen, N. K. Ames, L. D. Bourquin, and S. R. Rust, Michigan State University, East Lansing, MI.

The brown midrib-3 mutation has been incorporated into corn plants to reduce lignin and potentially improve fiber digestibility. It is our working hypothesis that physical fill limits DMI of light weight steers fed high corn silage diets. Therefore our objective was to determine if brown midrib-3 would improve digestibility and DMI of corn silage diets fed to light weight (224-24 kg) Angus crossbred steers. Eight ruminally cannulated steers were randomly assigned to a 2 x 2 factorial arrangement of treatments in a replicated 4 x 4 Latin square design. Steers were fed an 86% corn silage diet made from a corn hybrid (CON) or the same hybrid with the mutation (BMR). Diets were offered ad libitum or limited to 80% of ad libitum CON intake. Compared to CON, BMR corn silage had lower percentages of NDF (44.0 vs 39.5%), ADF (29.3 vs 22.4%), and ADL (3.7 vs 1.8%). Dry matter intake was 14% greater ($P < .01$) for steers offered ad libitum intake of BMR compared to CON. Feeding BMR, compared to CON resulted in improved ($P < .05$) apparent total tract digestibility of DM, OM, NDF, and ADF. Restricting intake resulted in decreased ($P < .05$) ruminal volume, digesta dry weight, and passage rate. Results from this trial suggest that full feeding BMR should improve predicted ADG by .21 kg/d.

Item	Ad Libitum		Limited		SEM	Effect ^a		
	CON	BMR	CON	BMR		I	H	I x H
DMI, kg/d	4.44	5.06	3.49	3.50	.21	***	***	***
Apparent total tract digestibility								
DM, %	70.4	73.1	67.4	72.7	1.3	NS	*	NS
NDF, % DM	53.1	63.6	49.5	65.3	2.1	NS	***	NS
ADF, % DM	56.1	65.5	52.1	67.5	2.0	NS	***	NS
DE, % DM	72.1	74.1	70.7	74.0	1.2	NS	†	NS
Ruminal digesta volume, L	27.2	28.3	25.3	23.5	2.2	***	NS	NS
Ruminal NDF passage rate, %/h	3.16	3.50	2.79	2.92	.24	**	NS	NS

^aI = intake; H = hybrid; I x H = intake # hybrid; NS = nonsignificant; #P < .10; *P < .05; **P < .01; ***P < .001.

Key Words: *bm₃* Corn Silage, Limit Feeding, Restricted Intake

283 Characterizing essential amino acid flow to the small intestine in cattle consuming limited levels of forage. E. J. Scholljegerdes*, B. W. Hess, and P. A. Ludden, University of Wyoming, Laramie, Wyoming/USA.

Eight Angus x Gelbvieh heifers (avg. initial BW 445 ± 74.5 kg) fitted with ruminal and duodenal cannulae were used in a 4 x 4 Latin square double cross-over designed experiment to assess the effect of restricted forage intake on flow of essential amino acids (EAA) to the small intestine. Heifers were fed chopped (2.54 cm) bromegrass hay (9.2% CP) at one of four percentages of maintenance (120%; 90%; 60%; 30%). Experimental periods were 21 d in length with 17 d adaptation followed by 4 d of intensive sample collection, after which maintenance requirements and subsequent levels of intake were adjusted for BW change. True ruminal OM digestion (g/d) declined linearly ($P < .0001$) with decreasing intake, but did not differ ($P = .57$) among treatments when expressed as percentage of OM intake (52.2 ± .04%). Total and microbial EAA flow to the duodenum declined linearly ($P = .0001$) from 482 to 137 g/d and 266 to 77 g/d, respectively, from 120 to 30% of maintenance intake. Total and microbial EAA profiles at the duodenum did not differ ($P = .06$ to .95 and .08 to .42, respectively) across treatments. These data were then used to develop a model to predict the amount and profile of

microbial and total EAA presented to the small intestine based on OM intake. The resulting simple linear regression equations were microbial EAA flow = 0.022 * OM intake + 7.236 ($r^2 = .72$) and total EAA flow = 0.055 * OM intake + 1.546 ($r^2 = .91$). Because total and microbial flow of EAA to the small intestine decreased as OM intake decreased, but EAA profile did not change, total or microbial EAA supply to the small intestine can be predicted based on OM intake. These prediction equations can be used to estimate the supply of EAA reaching the small intestine, which would be useful in formulating supplements to compensate for potential amino acid deficiencies resulting from restricted forage.

Key Words: Restricted intake, Amino acids, Cattle

284 Intake response to rumen and pre and post liver administration of monensin-sodium. S. Bierman* and R. Pritchard, South Dakota State University, Brookings, SD/USA.

Four steers (414 kg) were used to evaluate monensin-Na (MON) effects on DMI when dosed into the rumen or the portal or hepatic veins. A 4 x 4 Latin square trial was conducted with 7-d test periods consisting of pre-dose (d 2 and 3); dose day, MON was dosed at 1130 (d 4); and post-dose (d 5, 6 and 7) phases. There was a minimum of 11 d between periods. An 85% concentrate diet (1.99 Mcal NEm/kg and 1.27 Mcal NEg/kg) was fed daily at 1130 and individual bunk weight was recorded every 5 min for the first hour then every .5 h until 12 h post-feeding. Treatments included: C) control; R) 250 mg of MON injected into the rumen; P) 125 mg MON infused into the portal vein; and H) 3 mg MON infused into the hepatic vein. Pre-dose phase DMI was 106 7.2 g/kg BW^{3/4}. Interval DMI were not different across treatments ($P > .10$). Data were analyzed as accumulated DMI. Monensin-Na dosed into the rumen, portal or hepatic veins depressed DMI from 11.5 to 12 h ($P < .10$), but not after 13 h post-dose. Orthogonal contrast of R versus P and H treatment indicated that R 4.5 to 12 h dose day DMI was depressed (-31.9% of C), the P and H DMI were not (+7.8%; $P < .08$). The R, P and H dose day DMI decreased 1.5, 7.8 and 1.6%, respectively, of the pre-dose DMI while post-dose DMI increased a similar magnitude, 1.1, 4.7 and 2.3%, respectively, of pre-dose DMI. One steer was apparently insensitive to MON, his DMI increased 16.1% above the C when he was dosed with MON, the other 3 steers DMI decreased 14.3% ($P < .09$). When the insensitive steer was removed from the data set the H depressed dose d DMI at .25 through 1 h and at 11.5 compared to the P ($P < .08$). Rumen exposure to MON did not decrease DMI until 4.5 h post-dose ($P < .08$), indicating a delayed satiety signal. Monensin-Na decreases DMI when dosed into the rumen and the hepatic vein thus, the satiety signal is more than a rumen phenomena.

Key Words: Ionophore, Beef, Satiety

285 Comparison of self-limiting supplements for yearling steers grazing native range. C. S. Schauer*, G. P. Lardy, and K. K. Sedivec, North Dakota State University, Fargo.

Seventy yearling steers (349 ± 3 kg initial BW) were used in each of two years to evaluate different self-limiting supplements for yearling cattle grazing native range. Steers were stratified by weight and allotted randomly to supplemental treatment in one of ten 16-ha pastures. Experimental periods for year 1 consisted of three 28-d periods starting July 20 and ending October 12. Year 2 consisted of four 28-d periods beginning June 21 and ending October 8. Treatments were (2 pastures per treatment per year): control, no supplement (C); 16 % salt (S); 5.25 % anionic salts (ammonium chloride and ammonium sulfate; AS); 7 % calcium hydroxide (CaOH); and hand-fed, no limiter (HF). Supplements were based on wheat midds, barley malt sprouts, and soybean hulls. Calcium hydroxide was fed in meal form, all other supplements were pelleted. Supplements containing limiters were fed in portable feeders. Hand-fed supplements were fed in bunks. Dietary cation anion differences (DCAD; Na + K - Cl - S) for S, AS, CaOH, and HF of supplement were 12.9, -75.7, 13.9, and 14.3 mEq / 100 g, respectively. Supplement intakes (kg/d) were lower ($P < .05$) for HF than S and AS and lower ($P < .01$) for CaOH than AS. Average daily gain for S was higher ($P < .05$) than C in both years. Responses to AS and CaOH were variable across years. Supplement intake (% of BW) was lower ($P < .05$) for HF than S and AS, and CaOH was lower ($P < .05$) than AS. Based on supplement intake and ADG, S appears to be the most effective limiter for yearling steers grazing native range.

Item	Control	Salt	Anionic Salt	CaOH	HF	SEM
Initial wt, kg	349	351	350	350	346	3
Final wt, kg	404 ^a	438 ^d	423 ^{bc}	421 ^b	428 ^{bcd}	5
Supplement intake, kg/d		2.49 ^{bc}	2.85 ^c	2.13 ^{ab}	1.80 ^a	.19
Intake, % of BW		.61 ^{bc}	.72 ^c	.53 ^{ab}	.46 ^a	.04
ADG, kg/d						
Year 1	.48 ^a	.81 ^c	.55 ^{ab}	.62 ^{abc}	.70 ^{abc}	.07
Year 2	.64 ^a	.96 ^b	.90 ^b	.82 ^{ab}	.97 ^b	.07

a,b,c,d $P < .05$

Key Words: Yearling Steers, Anionic Salt, Supplement Limiter

286 Effects of oscillating dietary protein on growth and serum metabolites in growing steers. L. A. Ciminski*, T. L. Wechter, E. J. Scholljegerdes, P. A. Ludden, B. W. Hess, and D. D. Byerly, University of Wyoming, Laramie, WY.

Ninety-six Gelbvieh-Angus steers (avg initial BW = 270 ± .5 kg) were used in a 56 d experiment to evaluate the effects of oscillating dietary CP on growth and serum metabolite concentrations in growing beef steers. Steers were blocked by initial BW and randomly assigned to one of 16 pens (6 steers/pen) in a randomized complete block design. Four treatments consisted of either an 11, 13, or 15% CP diet fed daily, or a regimen in which dietary CP was oscillated between 11 and 15% on a 48-h basis (i.e. 11, 11, 15, 15, 11, 11; ACP). All diets consisted of 65% bromegrass hay (8.9% CP, 61% NDF, 37% ADF) plus 35% corn-based supplement, and were formulated to contain 8.5% of DM as DIP using a combination of soybean meal and urea. Treatment CP concentrations above 11% were accomplished with the addition of a UIP source (SoyPLUS[®], West Central Cooperative, Ralston, IA). All steers were fed at 3.0% of BW (DM basis) throughout the trial, resulting in an average DMI of 8.6 kg/d across treatments. Increasing CP from 11 to 15% linearly increased ($P = .007$) ADG from 1.07 to 1.25 kg/d, resulting in a linear increase ($P = .008$) in efficiency (kg gain/100 kg feed). Although ADG of ACP fed steers was not different ($P = .55$) from those fed the 13% CP diet daily, ACP fed steers had numerically higher ADG than those fed 13% CP daily (1.14 vs. 1.10 kg/d, respectively). Serum samples collected before feeding on 4 consecutive days at the end of the trial revealed a treatment x day of collection interaction ($P = .0001$) in serum urea N concentrations (SUN), with SUN of the ACP fed steers being lower on days when the 11% CP diet was fed. Overall, increasing CP linearly increased ($P = .0001$) SUN, but steers fed the ACP treatment had lower ($P < .07$) SUN than those receiving 13% CP daily (7.68 vs. 6.64 mg/dL, respectively). These results suggest that the ACP fed steers may have utilized protein with greater efficiency than those fed the same quantity of protein on a daily basis.

Key Words: Protein, Growth, Beef Cattle

287 Effects of processing field peas (*Pisum sativum*) in steer grower diets. E. J. Bock*, M. L. Bauer, G. P. Lardy, and T. C. Gilbery, North Dakota State University, Fargo.

Thirty crossbred steers (301 ± 15 kg) fed with electronic headgates were used to evaluate the effects of processing field peas (*Pisum sativum*) in grower diets. Calves were stratified by weight and allotted randomly to one of three treatments. Treatments included peas fed ground, rolled, or whole, with average particle size being 1428 μm, 3709 μm, and 5138 μm, respectively. The ground peas were processed using a hammermill with a 28.6-mm screen. Rolled peas were processed using a single-stage roller mill. Diets were formulated (DM basis) to contain 41.5% corn silage, 40% field peas, 15% alfalfa hay, and 3.5% supplement. Diets were formulated to be adequate in metabolizable and rumen degradable protein, and to contain 15% CP, .5% Ca, .3% P, 27.5 mg/kg monensin, and trace minerals and vitamins to meet NRC (1996) recommendations. Linear and quadratic contrasts were used to analyze the effect of particle size. Calves were fed ad libitum with 28-day weigh intervals. Weekly orts were collected, weighed, and sub-sampled. Initial and final weights for the 84 day trial were the average of weights taken three consecutive days after feeding at 2% BW for three days. Initial weights were used as a covariate ($P < .03$) for all variables measured. There was no difference in intake ($P > .38$) when expressed as kg/day or percentage BW. Steers fed whole and ground peas had higher ($P = .04$; quadratic) ADG and

final weights; and increased ($P = .10$; quadratic) feed efficiency than steers fed rolled peas. Processing does not appear to improve utilization of field peas when fed in a grower diet.

Item	Treatment			Contrast		
	Ground	Rolled	Whole	SEM	Lin	Quad
Weight, kg						
Initial	301	300	302	15	.96	.95
Final ^a	439	430	444	5	.42	.04
DMI						
kg/d ^a	9.86	9.77	10.05	.18	.49	.39
% BW ^a	2.68	2.68	2.71	.05	.63	.74
ADG, kg/d ^a	1.64	1.53	1.70	.05	.42	.04
Feed Efficiency, g/100g ^a	16.7	15.8	16.9	.5	.72	.10

^aInitial weights were used as a covariate ($P < .03$).

Key Words: Cattle, Field peas, Grower

288 Undegradable intake protein supplementation of compensating, grazing steers. K.W. Creighton*, M.D. Ullerich, and T.J. Klopfenstein, *University of Nebraska, Lincoln.*

A trial was conducted to evaluate the effects of previous winter gain on response to undegradable intake protein (UIP) supplementation of grazing steers. Forty-nine steers (228 kg; 11/24/98) were used in a 2x7 factorial treatment design; were wintered at two rates of gain, .71 (Fast, n=25) and .24 kg/d (Slow, n=24). Steers were then randomly assigned to one of six UIP supplements (n=3) or an energy control (n=7). Protein supplements were formulated to deliver 75, 112.5, 150, 187.5, 225, or 262.5 g/d of UIP, supplied by treated soybean meal and feather meal. Combinations of the protein and energy supplements provided the graded levels of UIP and all supplements were formulated to be isocaloric and were individually fed 4 d/wk. Steers grazed fertilized brome pastures (May 5 to Jun 11) and warm season species (Jun 11 to Aug 19). Forage samples contained on average (DM basis) 16.80% crude protein (CP) and 1.28% UIP (%DM) for brome, and 15.45% CP and 1.29% UIP for warm season grasses. A significant ($P=.09$) winter gain by UIP supplementation interaction was observed, therefore effects within winter treatment are reported. Fast cattle had a significant quadratic effect ($P=.09$) across UIP levels, with the maximum response occurring at the 150 g/d level. Slow cattle responded linearly ($P=.02$) to increasing UIP levels, however the response was negative. UIP levels above 150 g/d (fast) and 187.5 g/d (slow) reduced cattle gains, therefore, the data were reanalyzed excluding these levels. These new analyses showed that the fast cattle responded linearly ($P=.08$; .2kg/d) to increasing UIP, while the slow cattle had no response to UIP. Additionally, slow cattle experienced compensatory gain and had higher gains overall (.91 v. 1.23 kg/d for fast v. slow cattle receiving the energy control). Therefore, previous winter gain effected the response to UIP supplementation, with the fast winter gain group having a greater response. Furthermore, the negative effect of UIP levels above the requirements appears real but unexplainable.

Key Words: Undegradable intake protein, Compensatory gain, Grazing cattle

289 Effects of increasing dietary Rumesin[®] concentrations during an imposed acidosis challenge. M. P. Blackford*¹, C. T. Milton¹, T. J. Klopfenstein¹, D. J. Jordon¹, T. L. Scott¹, R. J. Cooper¹, and C. Parrott², ¹University of Nebraska, Lincoln, NE, ²Elanco Animal Health, Greenfield, IN.

Nine ruminally fistulated steers were used in a 9x2 Incomplete Latin square to evaluate increased dietary Rumesin[®] concentrations during an imposed acidosis challenge. Rumesin was fed at: 0g/ton (CON), 30g/ton (NOR), or 30g/ton fed prior to the challenge, and 45g/ton during and 5 d following the challenge (EXP). Steers were adapted to the finishing diet in 21 d utilizing 4 step-up rations. The finishing diet contained 63.4% high-moisture corn, 21.1% dry-rolled corn, 7.5% alfalfa hay, 3% molasses, and 5% supplement (DM basis). Each experimental period was 28 d: 14 d adaptation, 7 d pre-challenge, a short fed day (50% of d 21 feed offered), challenge day (175% of d 21 feed offered, 4 hr late), and 5 d recovery. Steers were housed in individual tie stalls with feed bunks suspended from load cells, and fitted with submersible ruminal pH electrodes. Ruminal fluid and jugular blood samples were

collected d 21, 23, 24, 25, and 26. Total VFA and jugular blood gas concentrations were similar among treatments. During the challenge and 5 d recovery, Rumesin fed steers had a higher molar % propionate ($P<.01$), and acetate:propionate ratio was lower ($P<.05$) than CON. Pre-challenge, steers fed Rumesin ate at a faster rate and had less ruminal pH variance ($P<.05$) compared with CON. Feed intake, number of meals per day, average meal size, and ruminal pH area below 5.6 were similar among treatments. During the challenge day, steers fed CON and EXP ate fewer meals ($P<.05$) and consumed more feed per meal ($P<.01$) than those fed NOR. Rumesin fed steers had less ruminal pH variance ($P<.05$); less ruminal pH area below 5.6 ($P<.05$) and 5.0 ($P<.01$) compared with CON. During the 5 d recovery phase, steers fed EXP had less ruminal pH area below 5.6 ($P<.05$) compared with CON and NOR. Feeding Rumesin at 30 or 45g/ton reduced acidosis on the challenge day, but the higher concentration (45g/ton) was necessary to reduce the effects of acidosis for 5 d following the challenge.

Key Words: Rumesin, Acidosis, Steers

290 Effect of barley and wet corn gluten feed combinations on performance and carcass characteristics of steers. E. R. Loe*, M. L. Bauer, G. P. Lardy, D. E. Schimek, and P. T. Berg, *North Dakota State University, Fargo.*

One hundred forty-four crossbred steers (298.9 ± 1.4 kg initial BW) fed for 170 d were used to evaluate barley and wet corn gluten feed (WCGF) combinations for finishing steers. Steers were blocked by weight and allotted randomly to treatment (6 pens/treatment). Diet contained 86.5% grain/concentrated separator by-product (CSB) and WCGF, 5% pressed beet pulp, 5% brome hay, 27.5 mg monensin/kg, and 11 mg tylosin/kg. Diets were formulated to contain a minimum of 12.5% CP, .7% Ca, .33% P, 1.1% K, .2% S, and 1.5 Ca:P. Wet corn gluten feed replaced 0, 19, 38, 57, and 76% of the barley and 0, 1, 2, 3, and 4% of the CSB. A sixth treatment consisted of corn replacing barley in the 40% WCGF treatment. Linear, quadratic, and cubic contrasts were used to compare the 0, 20, 40, 60, and 80% treatments. A contrast was used to compare the replacement of 40% barley or corn with WCGF. Initial weight was an average of three consecutive day weights. Final weight was calculated from hot carcass weight divided by 62% dress. Final weight increased (quadratic; $P = .04$) with increasing level of WCGF until decreasing at 80% replacement (565, 582, 586, 595, and 576 ± 7.7 kg, respectively). Dry matter intake increased (quadratic; $P < .01$) from 0 to 40% WCGF and decreased with higher inclusion (10.7, 11.2, 11.8, 11.5, and 11.0 ± .23 kg, respectively). Average daily gain increased (quadratic; $P = .03$) from 0 to 60% WCGF then decreased at 80% WCGF (1.56, 1.66, 1.70, 1.73, to 1.64 ± .05 kg/d respectively). Feed efficiency did not change with inclusion of WCGF. Corn fed steers had heavier final weights ($P = .04$; 610 vs 586 kg), lower DMI ($P < .001$; 10.4 vs 11.8 kg), greater gains ($P = .04$; 1.83 vs 1.70 kg/d), greater efficiency ($P < .001$; .177 vs .144), and more backfat ($P = .03$; .14 vs .12 cm) than barley-fed steers. Barley-fed steers had lower yield grades than corn-fed steers ($P = .02$; 2.48 vs 2.76). Dietary NE_g was higher for the corn diet ($P < .001$; 1.53 vs 1.22 Mcal NE_g/kg). Wet corn gluten feed increased DMI and ADG, presumably reducing acidosis in barley-based finishing diets.

Key Words: Steers, Wet Corn Gluten Feed, Barley

291 Implant programs using Synovex[®] Plus in feedlot heifers. C. N. Macken*¹, C. T. Milton¹, B. D. Dicke², D. McClellan³, and F. L. Prouty⁴, ¹University of Nebraska, Lincoln, NE, ²Cattlemen's Consulting, Lincoln, NE, ³McClellan Consulting, Fremont, NE, ⁴Fort Dodge Animal Health, Overland Park, KS.

Two commercial feedyard trials evaluated implant strategies in feedlot heifers. Trial 1 used 879 heifers (329 kg) randomly allotted to one of three treatments (15 pens; 5 reps/trt). Heifers were implanted with Ralgro[®] d 0, and reimplanted with either Synovex[®] Plus (SynPlus) or Finaplix[®]-H (FinH) 90 d prior to slaughter. MGA was fed to one SynPlus group and FinH heifers. Heifers were fed a steam-flaked corn-based diet, 149 d. Contrasts were used to compare the average of SynPlus implanted heifers versus FinH heifers, and the average of heifers fed MGA versus no MGA. Dry matter intake was similar (8.7 kg/d) between treatments. On a carcass-adjusted basis, SynPlus heifers, on average, gained 3.5% faster (1.50 vs 1.45 kg/d; $P = .01$) and were 3.7% more efficient (5.78 vs 6.00; $P = .01$) than FinH heifers. Feeding MGA, with either SynPlus or FinH, increased 12th rib fat ($P < .01$), yield grade ($P = .01$),

marbling score ($P < .01$), and the percentage of Prime ($P = .02$) and Low Choice ($P < .01$) carcasses compared with SynPlus and no MGA heifers. Implanting heifers with SynPlus and feeding MGA had an additive effect on carcass-adjusted net returns. SynPlus and MGA heifers returned \$11.26/hd ($P = .07$) more than FinH and MGA heifers. Trial 2 used 870 heifers (375 kg) randomly allotted to one of two implant treatments (6 pens; 3 reps/trt). Heifers were implanted with either SynPlus or FinH. Heifers were fed a dry-rolled corn-based finishing diet containing MGA, 107 d. SynPlus heifers gained 4.2% faster (1.50 vs 1.44 kg/d; $P = .02$) than FinH heifers. Dry matter intake was .31 kg/d higher ($P = .32$) for SynPlus heifers compared to FinH heifers. Feed efficiency was similar (avg 6.59) between treatments. Carcass weight was 4.5 kg heavier ($P = .10$) for heifers implanted with SynPlus compared to FinH. Other carcass traits were similar. Implanting heifers with SynPlus resulted in carcass-adjusted net returns \$5.73/hd greater ($P = .19$) than FinH heifers.

Key Words: Heifers, Implants, Feedlot

292 Comparison of finishing strategies for early or normal weaned steers. J.D. Arseneau*, R.P. Lemenager, and J.E. Tower, *Purdue University, West Lafayette, IN, USA.*

The objective of this study was to evaluate age at weaning and finishing strategy on performance, feed efficiency, and carcass characteristics of beef steers. Angus and Angus x Simmental steer calves ($n=72$) were allotted by age, breed, and weight to 1 of 4 treatments with 3 pens/treatment. Treatments were: 1) weaned at 74 d and placed on a high concentrate finishing diet (EWIF); or weaned at 190 d and fed 2) a high concentrate finishing diet (NWIF), 3) a high concentrate limit-fed diet for a 103 d growing period, and then a high concentrate finishing diet ad libitum (HCLF), or 4) a corn silage-based growing diet for 103 d, and then a high concentrate finishing diet ad libitum (CSG). Initial body weights were taken following a 17 to 24 day ration step-up period after weaning. Steers were harvested when the average estimated backfat (BF) for the treatment was 1.1 cm. Initial BW were 128 ± 6.9 kg for EWIF and 260 ± 9.7 kg for NWIF, HCLF, and CSG. Final BW were lighter ($P < .05$) for EWIF (511.9 kg) than NWIF (560 kg), HCLF (590.4 kg) and CSG (581.4 kg). NWIF steers gained faster ($P < .05$) than EWIF steers during the overall feedlot period (1.6 vs 1.4 kg/d), while HCLF and CSG were intermediate (1.5 kg/d). Feed efficiency (F/G) over the entire feedlot period was different ($P < .01$) between all treatments. EWIF steers were most efficient (5.11), followed by HCLF (5.56), NWIF (5.92), and CSG (6.25). EWIF steers were younger ($P < .01$) at slaughter (350 d) than NWIF (396 d), while HCLF (422 d), and CSG (422 d) were oldest ($P < .01$). Carcasses from EWIF steers were lighter ($P < .05$) than carcasses from HCLF and CSG steers, while weights of carcasses from NWIF steers were intermediate. There were no differences ($P > .10$) between treatments for DP (62.1%), REA (79.7 cm²), BF (1.2 cm), YG (3.1), marbling (507; 500=small⁰⁰), or QG (4.67; 4.0=high select). In this study, early weaned steers placed immediately on a finishing diet produced lighter carcasses, but were more efficient over the entire feedlot period and had similar YG and QG than normal weaned steers.

Key Words: Beef cattle, Weaning age, finishing strategy

303 The value of legume forage species for stockpiled forage grazing by calves. K. J. Vander Pol* and J.R. Russell, *Iowa State University, Ames.*

A 3-yr experiment was conducted to determine the effects of incorporating legume forage species into tall fescue on the chemical composition of stockpiled forage during the winter and BW gains of calves grazing this forage with corn crop residues (CCR). In spring 1996, a 7.29-ha field was divided into six 1.2-ha strips. Corn was planted on 40% of each strip. "Johnstone" endophyte-free tall fescue with no legume (TF), "Marathon" red clover (TF-RC), or "Amerigraze" alfalfa (TF-A) was seeded on the remaining 60% of the area in duplicate strips. In each year, summer forage growth from the forage strips was harvested as two cuttings of hay. Prior to stockpiling, urea was applied at 45 kg N/ha to the tall fescue strips in yr 1 and all strips in yr 2 and 3. After grain harvest, strips were crossfenced into four equal paddocks to allow simultaneous grazing of CCR and the stockpiled forages. At the initiation, middle, and termination of grazing, three .25-m² samples were taken from each grazed and ungrazed paddock containing stockpiled forage

and one 4-m² sample was taken from each grazed and ungrazed paddock containing CCR. Forage samples were analyzed for DM, OM, IVOMD, NDF, ADF, and ADIN. At the initiation of grazing, 18 weaned crossbred calves (mean BW, 197 kg) were allocated by weight and sex to the six strips to graze for 84-d. Organic matter yields of CCR at initiation of grazing were greater ($P < .01$) and decreased at a more ($P = .08$) rapid rate than stockpiled TF, TF-A, and TF-RC forages. Concentrations of IVOMD of stockpiled TF and TF-A forages were greater ($P < .05$) than CCR at the initiation of grazing, but the rates of change in IVOMD concentration did not differ between forage species. At the initiation of grazing, CP concentrations of stockpiled TF-A and TF-RC forages were higher ($P < .05$) than stockpiled TF forage which was higher ($P < .05$) than CCR. Forage species did not affect rate of change in CP concentration over winter. Daily BW gains of the calves grazing the TF, TF-A, and TF-RC were .19, .24, and .25 kg/d ($P = .07$) over 84 d.

Key Words: Grazing, Stockpiled forages, Legumes

304 Timing of realimentation of mature cows that were feed-restricted during pregnancy influences calf birth weights and growth rates. H. C. Freetly*, C. L. Ferrell, and T. G. Jenkins, *USDA, ARS, U.S. Meat Animal Research Center, Clay Center, NE.*

The objective was to determine the effect of feeding strategies that allowed weight loss followed by weight gain on the efficiency of feed utilization for calf production. The first treatment (H-H-H) was designed to maintain body condition score of mature cows at 5.5 from the second trimester until the subsequent breeding season. The second treatment (L-H-H) was designed such that cows lost body condition during the second trimester and regained it during the third trimester and were equal in weight and body condition scores at parturition to cows assigned to the H-H-H treatment. The third treatment (L-L-H) was designed such that cows lost body condition during the second trimester and gained body condition after 28 d of lactation so that they would be equal to the other two treatments at breeding. Forty-eight cows were assigned to each treatment. Total DM intake over the entire study did not differ between the H-H-H and L-H-H treatments ($P = .23$) but both were higher than the L-L-H treatment ($P = .0001$). Calf birth weight of the H-H-H treatment did not differ ($P = .43$) from those of L-H-H but both were greater than those of the L-L-H ($P \leq .002$) treatment. At 28 d H-H-H ($P = .008$) and L-H-H ($P = .007$) calves weighed more than the L-L-H calves but at 58 d of age there was no difference in calf BW among the treatments ($P = .81$). The percentage of cows that were diagnosed pregnant at weaning with their next calf did not differ ($P = .71$). The results of this study suggest that weight cycling in mature beef cows is a viable management tool for reducing feed cost.

Key Words: Bovine, Energy, Reproduction

305 Influence of breed, age and sex on plasma copper concentration in beef cattle. B. Hill*, J. E. Link, D. R. Hawkins, J. B. Barber, S. E. Kronner, and G. M. Hill, *Michigan State University, East Lansing, MI.*

Unthrifty calves with diarrhea, reduced growth and disease resistance and rough, faded hair coats are characteristics of inadequate copper (Cu) intake in beef cattle. Our previous three year (1993-95) evaluation of the Michigan State University beef herd, revealed that plasma Cu concentration in cows (age > 730 d) decreased (130 to 85 $\mu\text{g}/\text{dl}$, $P < .05$) regardless of breed. This marginal Cu status occurred when the only dietary Cu sources were forage and trace mineral (TM) salt containing cupric oxide (CuO). Thus, the objective of this study was to determine if adding Cu sulfate to the diet would increase plasma Cu concentration in the herd. After feeding traditional feedstuffs for an additional 18 months, 48 g Cu sulfate/kg was added to the TM salt. Cattle were bled annually for three years (1996-98) for determination of plasma Cu by atomic absorption spectrometry. Samples were obtained from 533 females (142 Hereford = H, 186 Angus = A, 205 Crossbred = C) and 55 bulls (H = 38, A = 17). In cows, plasma Cu concentration varied with year (93, 78 and 106 $\mu\text{g}/\text{dl}$ respectively, $P < 0.05$), increasing 36 % after Cu sulfate intervention. Because bulls had adequate Cu status, their plasma Cu concentration did not change following intervention (115, 100, 112 $\mu\text{g}/\text{dl}$, respectively). Bull calves (age < 365 d) had higher plasma Cu than mature bulls regardless of breed (110 vs 98 $\mu\text{g}/\text{dl}$). A similar trend was observed for heifer calves (age < 365 d),

heifers (365 > age < 730 d) and cows (107, 94, 89 $\mu\text{g}/\text{dl}$, respectively). There was a significant age X breed and year X breed interaction in females but not males. These data indicate, that due to reproductive demands, the Cu status of female cattle is more readily affected by a Cu source with low bioavailability, such as CuO. Cu sulfate or an equivalent bioavailable source must be supplemented to beef cattle to maintain adequate Cu status.

Key Words: Cattle, Copper

306 Supplementation based on the metabolizable protein system versus the crude protein system for primiparous heifers grazing winter range. H. H. Patterson*, D. C. Adams, and T. J. Klopfenstein, *University of Nebraska, Lincoln, NE.*

Two experiments were conducted to evaluate the response of winter supplementing grazing heifers to meet metabolizable protein (MP) requirements versus conventional CP supplementation and to evaluate effects of winter hay supplementation. In Experiment 1, 12 March calving, primiparous heifers (432 25 kg) grazing upland Nebraska Sandhills range were randomly allotted to one of two treatments (6/treatment); 1) suppl. to meet MP requirements (MPR) or 2) suppl. to meet CP requirements (CPR). Supplements were fed to individual cows from October to February, and no hay was offered. Grazed forage intake (FI) was measured in November, January, and February. In Experiment 2, 18 heifers (425 16 kg) were randomly allotted to one of three treatments (6/treatment); 1) suppl. to meet MP requirements with hay fed in January and February (average 2.3 kg/day; MPR/H), 2) suppl. to meet CP requirements with hay fed in January and February (CPR/H), or 3) suppl. to meet MP requirements with no hay fed (MPR/NH). Supplements were fed from October to February, and FI was measured in December and February. In Experiment 1, heifers on the MPR treatment gained 5 kg body weight (BW) over the winter whereas CPR heifers lost 12 kg ($P = .04$). Grazed FI declined linearly ($P < .01$) from 2.2% BW in November to 1.6% in February, with no treatment differences. In Experiment 2, heifers on the MPR/NH treatment lost more BW (-52 kg) over the winter than the MPR/H (-12 kg) and CPR/H (-10 kg) treatments ($P < .01$). Grazed FI declined ($P < .01$) from 1.7% BW in December to 1.4% in February, with no treatment differences. Heifers on the MPR/H and CPR/H treatments had higher total intake (grazed FI + hay intake) in February (2.0% BW) than the MPR/NH heifers ($P < .01$). Supplementing heifers to meet MP requirements decreased over-winter weight loss in one of two experiments, and supplementing hay in January and February reduced over-winter weight loss. Intake of grazed forage declined from November to February.

Key Words: Metabolizable Protein, Heifers, Intake

307 Forage production and quality of an early grazed hay meadow. A. D. Schleicher*, B. W. Hess, D. W. Koch, and L. J. Held, *University of Wyoming, Laramie, WY.*

Eighty-eight Angus x Gelbvieh rotationally crossed heifers (avg. BW = 361.3 kg) grazed a 16.2 ha pasture from May 26, 1999 to June 8, 1999 to determine the effects of early grazing on forage production and quality. Three areas of similar species composition were present: native grasses, native grasses and Garrison creeping foxtail (*Alopecurus arundinaceus* Poir), and Garrison creeping foxtail. Forage cages (.37 m²) were located throughout each of the three areas for an ungrazed comparison. Samples (immediately before and after grazing) were separated into live or dead specimens, dried, weighed, ground, and analyzed for DM, ash, NDF, ADF, CP, soluble CP, neutral detergent insoluble CP (NDICP), acid detergent insoluble CP (ADICP), and IVDMD. Data were analyzed as a factorial arrangement of treatments within a completely randomized design. A specimen type x sampling date interaction existed ($P = .0003$) for forage production (Dead, before grazing = 929.7 kg/ha; Dead, after grazing = 383.3 kg/ha; Live, before grazing = 589.7 kg/ha; Live, after grazing = 1061.0 kg/ha). A species x specimen type interaction was noted ($P = .001$) for CP with Garrison creeping foxtail being greatest (16.9% CP) and no differences in dead samples across species (4.8 .4% CP). Dead samples had greater ash ($P = .0003$), NDF ($P = .004$), ADF ($P < .0001$), NDICP ($P < .0001$), and ADICP ($P < .0001$), whereas live samples had greater soluble CP ($P = .001$) and IVDMD (Live = 80.9%; Dead 59.9%; $P < .0001$). Species type influenced ash ($P = .05$), ADF ($P = .007$), CP ($P = .01$), and IVDMD ($P = .04$). Grazing did not affect forage production ($P = .36$) or nutrient content ($P = .10$

to .95). Live and dead specimens and forage species, but not grazing, influenced nutrient content. From these results, it would appear that short duration, early grazing is not detrimental to forage production or quality of native hay meadows.

Key Words: Grazing, Forage production, Forage quality

308 Evaluation of alfalfa leaf meal in creep feeding diets. L.R. Miller*¹, C.M. Zehnder¹, G.C. Lamb², A. DiCostanzo¹, and A. Miron³, ¹University of Minnesota, St. Paul, MN, ²North Central Research and Outreach Center, Grand Rapids, MN, ³Harvest States/Land O Lakes Feeds, Sioux Falls, SD.

Two trials were conducted in 1998 and 1999 at two locations to determine the effects of including alfalfa leaf meal (ALM) in creep feeding supplements on calf weight gain and efficiency of utilization. Eighty-eight (40, year 1, or 48, year 2) Charolais and Simmental calves and 184 (72, year 1 or 96, year 2) Angus calves (initial BW, 140 kg) were used each at location 1 and 2, respectively. Calves were stratified by weight and sex and randomly assigned to one of three dietary treatments for a 76-d (year 1) or 92-d (year 2) supplementation period starting on August 1 (year 1) or July 15 (year 2), respectively. Calves were not implanted. Cow-calf pairs were rotationally grazed on predominately blue grass paddocks. Treatments were control (no creep feed; n=2 replicates/yr), ALM-based creep feed (58% ALM as-fed basis; n=2 or 3 replicates/yr), or a wheat midds (MIDD; n=2 or 3 replicates/yr) based creep feed. Creep feeds contained 1.08 Mcal NE_g/kg DM and 17% CP and offered ad-libitum. Milk yield was similar among treatments as estimated by the weigh-suckle-weigh technique at the beginning and end of each trial. In year 1, calves on ALM and MIDD creep feeds had greater ($P < .05$) ADG than calves fed no creep feed (.99, 1.21, 1.20 kg/d for control, ALM, and MIDD, respectively). In year 2, calves supplemented with MIDD or ALM creep feed had greater ($P < .05$) ADG than those fed no creep feed; calves supplemented with MIDD creep feed had greater ($P < .05$) ADG than those supplemented with ALM creep feed (1.24, 1.39, 1.56 kg/d for control, ALM, and MIDD, respectively). Calves supplemented with MIDD had higher ($P < .05$) creep feed DMI than those supplemented with ALM (1.31 and 2.64 kg/d for ALM, and MIDD, respectively). Feed efficiencies for additional gain by calves supplemented with ALM or MIDD were 7.44 or 10.04 kg creep feed/kg additional gain, respectively. Alfalfa leaf meal may substitute conventional creep feed ingredients at similar ADG and lower creep feed DMI.

Key Words: Alfalfa, calves, creep feed

309 Energy, DIP, or UIP as the first limiting nutrient for gain in nursing calves grazing native range in southeastern North Dakota. T. W. Loy*, G. P. Lardy, M. L. Bauer, and J. S. Caton, *North Dakota State University, Fargo, ND.*

A 2-yr study (1998, 1999) was conducted to determine the first limiting nutrient for gain in nursing calves grazing native range in southeastern North Dakota. Thirty-two calves (20 steers, 12 heifers) in 1998, and 31 (16 steers, 15 heifers) in 1999 (191 \pm 6 kg initial BW) grazed common pastures. Calves were blocked by sex and stratified by weight. Calves were stratified by age of dam in 1998 and by pre-trial milk intake (MI) in 1999. Treatments were non-supplemented control (C); energy supplement (E; 100% soyhulls); degradable protein supplement (DIP; 62% soyhulls, 38% SBM); and degradable with undegradable protein supplement (DIP+UIP; 80% sulfite-liquor treated SBM, 16% feather meal, 4% blood meal). In 1999, 5% molasses was added to all supplements with the ratios of other ingredients held constant. Supplements were formulated to be similar in ME. The DIP and DIP+UIP treatments supplied equal amounts of degradable protein. Supplemented calves were fed individually, with similar supplement DMI. Weight and MI were measured in July, Aug, and Sept. Forage intake (FI) was estimated in July, Aug, and Sept of 1998; and July and Aug of 1999. Gain data were analyzed as a randomized complete block, and MI and FI as a split-plot in time. Orthogonal contrasts were used to separate means and included C vs supplemented, E vs protein, and DIP vs DIP+UIP. No year effect or year x treatment interaction ($P > .3$) was detected for ADG. Supplemented calves gained faster than C ($P = .06$). No other contrast differences were observed ($P > .5$). Treatment did not affect FI ($P > .5$). A year effect was detected for FI expressed as kg OM/d ($P < .01$) but not when expressed as %BW ($P > .5$). A linear and quadratic increase in FI and FI %BW occurred over time in both years ($P < .01$). No year, treatment, or period differences were detected for MI ($P > .3$).

These data indicate that energy may be limiting weight gain of nursing calves grazing native range in southeastern North Dakota.

Key Words: Nursing calves, Supplementation, Intake

310 Bloodmeal and fishmeal improves efficiency of growing cattle. J. W. Lehmkuhler* and M. S. Kerley, *University of Missouri, Columbia, MO/USA*.

Addition of UIP to feedlot diets can increase the efficiency of growing cattle. Microbial amino acid flow may not meet the requirement for cattle with high growth potential (greater than 2kg live weight gain/d). The hypothesis that UIP can increase performance and efficiency of growing steers was investigated. A preliminary study utilizing 37 steers (initial BW=364kg) was conducted to investigate the response to varying levels of (BM). Steers were fed a basal diet consisting of 15.3% corn silage, 51% high moisture corn, and 33.7% dry corn. Treatments were topdressed allowing for 0, 200, 500, and 900 g of BM/hd/d. Calculated CP were 17.6%, 20.2%, 20.1%, and 23.0% for treatments 0, 200, 500, and 900 g BM, respectively. No differences were detected for DMI, FE, or GE (averaged 8.6kg, 3.8, and 0.26, respectively). A trend ($P=.11$) was observed for increasing ADG from 0 to 500 g BM intake (2.1, 2.2, and 2.5kg) while 900 g was intermediate to the 200 and 500 g levels at 2.3kg. A second study utilizing 118 predominantly Angus steers (initial BW=295kg) investigated responses to inclusion of 0, 1.5, 3.0, 6.0, or 12.0% (% of DM) of a 1:1 mix of BM and fishmeal (BMFM) with four replicates per level. A basal diet consisting of 50% high moisture corn, 24% dry corn, 12% whole soybeans, 10% chopped hay, and 4% mineral and vitamin supplement was fed ad libitum. BMFM was topdressed and cracked corn was utilized to maintain a constant level of energy intake. Steers were weighed and the loin-eye area was scanned using ultrasonography for backfat, rib muscle depth and marbling every 14 d over a 70 d period. DMI, loin-eye area, backfat, and marbling throughout the 70 d study were similar among the various levels of BMFM. Including BMFM in the diet at 6% improved ADG and FE (1.9kg versus 1.72kg; 4.0 versus 4.4 for 6% and 0%, respectively) while additional BMFM did not improve performance and efficiency when compared to the lower levels. Feeding UIP to growing beef steers can improve feed efficiency and performance without negatively affecting DMI.

Key Words: Undegradable Intake Protein, Amino Acid, Marbling

311 Influence of diet on colonic pH and generic and acid-resistant *Escherichia coli* in beef steers. T. L. Scott*, C. B. Wilson, D. Bailey, T. J. Klopfenstein, C. T. Milton, R. A. Moxley, D. R. Smith, J. T. Gray, and L. L. Hungerford, *University of Nebraska-Lincoln*.

Three finishing diets based on dry-rolled corn (DRC), high-moisture corn (HMC), or wet corn gluten feed (WCGF) were fed to 9 steer calves to determine the effect of diet on colonic pH and most probable number (MPN) of total (TOT) and acid-resistant (AR) *E. coli* populations. Diets were formulated to contain a minimum of 12.5% CP, .7% Ca, .35% P, .6% K, and included 25 g/ton Rumensin and 10 g/ton Tylan. In Exp.1, diets were fed in a replicated 3x3 Latin square design with steers being limit-fed (75% of ad libitum) during d 1-9 and offered feed ad libitum during d 10-21 of each period. In Exp. 2, 3 steers previously being fed each diet were switched to alfalfa hay (ALF) feeding for 5d. Limit-feeding did not affect TOT or AR *E. coli* populations; however, colonic pH was lower ($P < .10$) in steers fed DRC or HMC compared with those fed WCGF. During ad libitum feeding, TOT *E. coli* populations were not different; however, AR populations were lower ($P < .10$) in steers fed DRC or HMC compared with steers fed WCGF. Colonic pH was higher ($P < .10$) in steers fed HMC or WCGF compared with steers fed DRC. In Exp. 2, there were no differences among the finishing diets when steers were switched to ALF; therefore, data were pooled to compare finishing diets with ALF feeding. Feeding ALF lowered ($P < .01$) TOT and AR *E. coli* populations and increased ($P < .01$) colonic pH when compared to feeding finishing diets. The MPN of AR *E. coli* was reduced from 3.99 log₁₀ units for finishing diets to 1.34 log₁₀ units for ALF. Dietary manipulation of finishing diets either by substituting ingredients or limit-feeding increased colonic pH; however, increased colonic pH was not associated with reduced populations of AR *E. coli*. Alfalfa hay feeding increased colonic pH and decreased AR *E. coli*.

Key Words: *Escherichia coli*, Restricted Feeding, Unrestricted Feeding

312 Effects of corn and four levels of soybean meal fed with prairie hay to beef steers on intake, digestion and fecal concentration of nitrogen, starch and ADF. T. N. Bodine*¹, H. T. Purvis II¹, and C. J. Ackerman², ¹Oklahoma Agricultural Experiment Station, ²Oregon State University.

An 8 x 8 latin square experiment with a 2 x 4 factorial arrangement of treatments was designed to determine the effects of supplemental corn and 4 levels of soybean meal fed with prairie hay on apparent total tract digestion of nitrogen, starch and ADF. Eight ruminally cannulated steers (318 kg) were fed ad lib prairie hay with 0% (NC) or .75% (CR) BW cracked corn, each with four levels of supplemental DIP (0.4, 0.7, 1.0, or 1.3 g DIP/kg BW). Intake of ADF exhibited an interaction ($P < .03$) between levels of corn and DIP. The ADF intake increased quadratically ($P < .05$) with increasing DIP for CR (0.4-1.3 g DIP/kg BW, respectively; 2594, 2983, 2944, 2742 g) and NC (0.4-1.3 g DIP/kg BW; 2650, 3460, 3415, 3340 g). An interaction ($P < .07$) between levels of corn and DIP was noted for digestion of N and ADF. Added DIP linearly increased ($P < .01$) digestion of N and ADF for CR (0.4-1.3 g DIP/kg BW; N, 45, 54, 54, 64%; ADF, 44, 57, 56, 64%). Digestion of N (0.4-1.3 g DIP/kg BW; 32, 54, 60, 64%) for NC increased quadratically ($P < .01$) while ADF digestion (60%) was not altered ($P > .38$) by increasing DIP. Starch digestion (88%) was not altered ($P > .99$) by added DIP in CR diets. Fecal N had an interaction ($P < .02$) between levels of corn and DIP. Fecal N increased linearly ($P < .01$) for CR (0.4-1.3 g DIP/kg BW; 1.4, 1.7, 1.9, 2.2%) and quadratically ($P < .01$) for NC (0.4-1.3 g DIP/kg BW; 1.4, 1.8, 1.9, 2.1%). Fecal starch concentration was greater ($P < .01$) for CR than NC (6.6, 2.8%). No interaction ($P > .17$) between levels of corn and DIP was noted for fecal ADF. Increasing DIP resulted in a linear decrease ($P < .01$) in fecal ADF concentrations (0.4-1.3 g DIP/kg BW; 46, 42, 40, 37%) while diets without corn (NC) had greater ($P < .01$) fecal ADF concentrations (44, 39%) than those with corn (CR). As DIP increased, ADF intake and N digestion increased in all diets. For diets fed with corn, increasing DIP increased ADF digestion and appeared to reduce the negative effects of starch on fiber digestion.

Key Words: Protein, Starch, Fiber digestion

313 Increasing levels of monensin in limit-fed, high-energy growing diets for beef steers and effects on subsequent finishing performance. S. P. Montgomery*, J. S. Drouillard, J. J. Sindt, T. B. Farran, H. J. LaBrune, R. D. Hunter, J. J. Higgins, and T. A. Nutsch, *Kansas State University, Manhattan*.

Crossbred beef steers (n=164, 261 kg) were used in a randomized complete block design to determine optimum monensin concentration in limit-fed, high-energy growing diets. Steers were fed a common diet ad libitum for 14 d preceding the growing phase to minimize differences in gastrointestinal tract fill. Steers were allotted to pens containing five to seven animals with nine pens per treatment. Growing diets contained 80% concentrate and 20% ground alfalfa hay, and provided 33, 44, or 55 mg/kg of monensin (M33, M44, and M55). Diets were fed once daily at 1.8% of body weight for 88 d. Prior to obtaining final weights for the growing phase, cattle were fed a common diet ad libitum for 14 d. ADG for the 102-d growing phase were 1.25, 1.27, and 1.25 .06 kg/d and gain efficiencies were .216, .220, and .218 .004 kg gain/kg DM for M33, M44, and M55, respectively. ADG and gain efficiencies were not different among treatments ($P > .80$). At the end of growing phase steers were placed onto a common finishing diet, fed for 101 d, and then slaughtered. The final finishing diet contained 82% steam flaked corn, 7% ground alfalfa hay, 33 mg/kg monensin, and 11 mg/kg tylosin and was fed once daily ad libitum. Finishing ADG were 1.43, 1.43, and 1.54 .06 kg/d and gain efficiencies were .152, .155, and .158 .003 kg gain/kg DM for M33, M44, and M55, respectively. M55 finishing ADG was greater ($P < .02$) than M33 or M44. This resulted in heavier carcass weights for M55 compared to M33 ($P < .05$) and M44 ($P < .12$). Gain efficiency was not different ($P > .40$) among treatments. Including higher concentrations of monensin in limit-fed, high-energy growing diets may increase subsequent ADG and carcass weight.

Key Words: Monensin, Limit feeding, Cattle

314 Combinations of wet corn gluten feed and steam flaked corn in finishing cattle diets. J. J. Sindt^{*1}, J. S. Drouillard¹, S. P. Montgomery¹, T. B. Farran¹, H. J. LaBrune¹, R. D. Hunter¹, J. J. Higgins¹, R. T. Ethington², and R. U. Lindquist², ¹Kansas State University, Manhattan, ²Minnesota Corn Processors, Inc., Marshall, MN.

Six hundred and fifteen crossbred beef steers (291 kg) were used in a 152-d experiment to evaluate finishing performance when steam flaked corn was replaced with wet corn gluten feed. Steers were blocked by previous treatment and randomly allocated, within block, to each of three diets (4 pens per diet, 48 to 53 steers per pen). Dietary treatments consisted of 0 (0CGF), 30 (30CGF), and 60% (60CGF) wet corn gluten feed (DM basis). Final diets contained 7% alfalfa, 2% tallow, 33 mg/kg monensin, and 11 mg/kg tylosin. Steers were implanted with Component[®] TE-S on day 1, and were adapted to the final diet within 23 d. On d 114 to 118, samples of rumen fluid and feces were collected from 180 steers (60 per treatment) for determination of ruminal and fecal pH. A linear increase was observed for both ruminal pH (6.07, 6.15, 6.23; $P < .01$) and fecal pH (6.78, 6.81, 6.94; $P < .01$) for 0CGF, 30CGF and 60CGF, respectively. Dry matter intake tended to increase ($P = .13$) as the proportion of CGF increased (8.64, 8.70, and 9.01 kg/d for 0CGF, 30CGF, and 60CGF). Daily gains were 1.42, 1.46, and 1.38 kg/d and gain efficiencies were .165, .168, and .154 for 0CGF, 30CGF, and 60CGF, respectively. Cattle fed 60CGF gained less than cattle fed 30CGF ($P < .01$) and were less efficient than cattle fed to 0CGF ($P < .02$), and 30CGF ($P < .01$). Carcass weight was not affected ($P > .3$) by treatment. Dressing percentages were 61.3, 61.5, and 60.7 for 0CGF, 30CGF, and 60CGF, respectively. Dressing percentage was lower ($P < .03$) for cattle fed 60CGF compared to cattle fed 30CGF. Incidence of liver abscesses increased linearly (1.5, 2.0, 3.9; $P < .05$) as the level of CGF was increased. Replacing steam flaked corn with wet corn gluten feed at 30 percent DM yielded performance similar to steam flaked corn.

Key Words: Wet corn gluten feed, Steam flaked corn, Cattle

315 Evaluating the relationship between blood glucose, performance, morbidity, and mortality in receiving heifers. H. J. LaBrune^{*}, J. S. Drouillard, T. B. Farran, J. J. Sindt, S. P. Montgomery, and R. D. Hunter, Kansas State University, Manhattan, KS.

Crossbred beef heifers ($n = 332$; 183 kg) of Southeast origin were used in a 36-d receiving trial to evaluate blood glucose as a tool to predict ADG, mortality, and morbidity rate. Cattle were provided grass hay and water on arrival and were processed within 24h. Cattle were implanted, vaccinated against common viral and clostridial diseases, treated for internal and external parasites, and given a metaphylactic dose of tilmicosin (.033 ml/kg BW) at processing. Blood glucose (Gluc) was measured using a hand held glucose monitor (Glucometer Elite, Bayer Corp.). Plasma was obtained from 178 heifers to determine concentration of plasma urea nitrogen (PUN) and plasma glucose (UVGluc) using a colorimetric assay. Heifers were categorized into high (≥ 58 mg/dl; GlucH) and low (< 58 mg/dl; GlucL) glucose groups, as well as high (≥ 1.06 mmol; PUNH) and low (< 1.06 mmol; PUNL) PUN groups. Cattle were identified as candidates for therapeutic treatment when they exhibited clinical symptoms of respiratory disease, and were treated (.033 ml tilmicosin/kg BW) when rectal temperature exceeded 39.7°C. Candidates for retreatment were similarly identified and were administered oxytetracycline and tylosin at .13 and .11 ml/kg BW, respectively. Plasma glucose was regressed against blood glucose for validation, revealing a positive linear relationship ($UVGluc = 36.19 + .93Gluc$; $P < .0001$; $r^2 = .37$). ADG were $1.06 \pm .05$ and $1.21 \pm .04$ kg/d for GlucH and GlucL respectively ($P < .02$). Treatment rates were not different ($P > .5$) for GlucH and GlucL, but mortality rate was higher ($P < .02$, 6.82 and 1.5% respectively) and retreatment rate tended ($P = .15$) to be greater for GlucH than for GlucL. GlucH in conjunction with PUNH depressed ADG ($P < .02$) compared to other Gluc/PUN combinations. Contradictory to Gluc, treatment rate was higher ($P < .01$) for UVGlucH than for UVGlucL. Measuring blood glucose levels on arrival may be useful to identify cattle at risk to bovine respiratory disease.

Key Words: Glucose, Cattle, Respiratory Disease

316 Ruminal digestion and fermentation patterns of heifers receiving supplemental soybean oil or corn while grazing summer pasture. L. Brokaw^{*}, B. W. Hess, and D. C. Rule, University of Wyoming, Laramie.

Nine Angus \times Gelbvieh rotationally crossed heifers (302 ± 44 kg initial BW) with ruminal and duodenal cannulae were used in a split-plot designed experiment to determine the effects of soybean oil or corn supplementation on intake and ruminal digestion and fermentation patterns. Beginning June 8, 1998, heifers continuously grazed a 6.5 ha bromegrass pasture and received one of three treatments: no supplementation (CON); daily supplementation of corn at .345% BW (CRN); and daily supplementation of corn plus soybean oil (12.5% of DM) at .3% BW (OIL). Soybean oil replaced corn on a TDN basis and corn gluten meal was included with the oil to provide isoenergetic and isonitrogenous supplements. Three 23 d periods consisted of 14 d of adaptation followed by 9 d of sample collections. Treatment (CON vs CRN+OIL; CRN vs OIL) and sampling period (polynomial) effects were evaluated using orthogonal contrasts. Supplementation did not influence forage ($P = .31$) and total ($P = .14$) OM intake or total VFA ($P = .23$). True ruminal OM disappearance and microbial N flow to the duodenum tended to be greater ($P = .07$ and $P = .09$, respectively) for CON heifers. Microbial efficiency was greater ($P = .05$) for CON heifers. Microbial efficiency and N flow to the duodenum declined linearly ($P = .0001$ and $P = .02$, respectively), whereas ruminal acetate:propionate increased linearly ($P = .0001$) as the grazing season advanced. Ruminal molar proportions of acetate were greater ($P = .01$) for CON heifers. Ruminal molar proportions of propionate were greater ($P = .03$) for CRN than OIL heifers. Ruminal acetate:propionate ratio tended to be greater ($P = .08$) for CON heifers and was greater ($P = .02$) for OIL than CRN heifers. Supplementation had slight negative effects on ruminal digestion; however, supplemental soybean oil did not further reduce digestion. Therefore, replacement of corn with soybean oil at the levels reported herein is a viable supplementation strategy.

Key Words: Supplementation, Intake, Digestion

317 Undegraded intake protein value of corn steep compared to soybean meal. H. H. Patterson^{*1}, T. J. Klopfenstein¹, D. J. Jordon¹, C. B. Wilson¹, and R. A. Stock², ¹University of Nebraska, Lincoln, NE, ²Cargill Corn Milling, Blair, NE.

Corn steep (CS) is a combination of corn steep liquor and condensed distillers solubles. The distillers solubles contain heated yeast cells, which have been shown to be high in undegraded intake protein (UIP). In vitro ammonia release experiments have shown CS to have a similar UIP value (32.8% of CP) to soybean meal (SBM; 29.6%), but this has not been validated in vivo. The objective of this experiment was to determine the UIP value of CS compared to SBM for growing calves. Thirty calves (216–26 kg) were individually fed a diet containing 40% sorghum silage, 20% ground corncobs, 20% dry corn bran, and 20% supplement (DM). Calves were stratified by sex and randomly allotted to one of three treatments and level of protein within treatment. Treatments included 1) supplement to supply degraded intake protein with urea and corn bran (6 calves, urea control), 2) SBM replacing urea and bran in the supplement at 25, 50, 75 or 100% of the supplemental protein (3 calves/level), and 3) CS replacing urea and bran at 25, 50, 75 or 100% of the supplemental protein (3 calves/level). The CS was mixed with bran and fed as wet corn gluten feed. The calves were fed the respective diets for 84-d. Protein efficiency, calculated as gain above the urea control regressed on natural protein intake above the urea control, was compared for each treatment using the slope-ratio technique. Calves on the urea control gained .7 kg/day, and the maximum gain realized by calves supplemented with either SBM or CS was 1.0 kg/day. Natural protein intake above the urea control ranged from 84 to 314 g/day for the SBM treatment and from 87 to 391 g/day for CS treatment. Protein efficiency was 1.04 .45 and .92 .26 for the SBM and CS, respectively ($P > .10$). The similar protein efficiency between SBM and CS, combined with similar in vitro ammonia release data, indicate that both feedstuffs have comparable UIP content (30% of CP) in growing calf diets.

Key Words: Corn Steep, Undegraded Intake Protein, Calves

318 Large round bale feeder design affects wastage of hay. D. D. Buskirk^{*}, T. M. Harrigan, A. J. Zanella, and D. R. Hawkins, Michigan State University.

One-hundred-sixty non-lactating, gestating beef cows (631–78 kg) were used to evaluate the quantity of hay loss from different designs of round bale (RB) hay feeders. Within two weight blocks, cows were equally

allotted by body condition score (5.9 .3) to one of four treatments in eight outside pens. Each pen was assigned to one RB feeder treatment 1) Ring, 2) Cone, 3) Cradle, or 4) Trailer, which was placed on a concrete pad. Round bales (1.2 x 1.5 m; 281–24 kg) were stored inside and individually weighed prior to feeding. Cows were given ad libitum access to hay in the feeders for a 7-d period. Feeder treatments were rotated among pens and the trial was repeated for a second 7-d period. Hay that fell onto the concrete surrounding the feeders was collected daily, weighed, and sampled. Disappearance of hay was calculated as hay delivered to each pen, less residual hay in the feeder at the end of 7-days. Wastage of hay was calculated as the quantity of hay recovered from the perimeter of each feeder. Intake of hay was estimated as the difference between disappearance and wastage of hay. Mean wastage of hay was 8.9 percent of hay DM disappearance. Wastage of hay was 3.5, 6.1, 11.4, and 14.6 percent of hay DM disappearance for the Cone, Ring, Trailer, and Cradle feeders, respectively. Both round feeders (Cone and Ring) had less hay wastage than the Cradle or Trailer feeders ($P < .05$). There was a trend for less hay wastage from the Cone feeder compared to the Ring feeder ($P = .08$). The Cradle feeder had the greatest ($P < .05$) amount of hay wastage of the feeder designs tested. Estimated hay dry matter intakes, were similar ($P > .20$) among feeders and were within an expected range (1.8 to 2.0 percent of BW). This study demonstrated that wastage of hay was significantly influenced by RB feeder design.

Key Words: Feed wastage, Hay loss, Forage utilization

319 The impact of pregnancy on jejunal cellular proliferation in beef heifers. A. N. Scheaffer*, J. S. Caton, M. L. Bauer, and L. P. Reynolds, ¹North Dakota State University, Fargo.

Beef heifers (24 mo; 384 ± 11 kg initial BW; 30 pregnant; 22 non-pregnant) were grouped in common pens and fed corn silage and hay-based diets formulated to provide .45 kg of ADG in non-pregnant (NP) cows. Heifers were slaughtered on d 0, 40, 120, 200, and 270 of the study. For the pregnant (PR) heifers, slaughter period corresponded with day of gestation. Jejunal tissue was collected by sampling the mid-point of the small intestine. Samples were processed using standardized histological techniques. Cellular proliferation (proliferating cell nuclear antigen; PCNA) was quantified histologically, using 20 randomly selected fields for each sample. A computerized image analysis system was used to evaluate PCNA labeling. Jejunal tissue morphometry was estimated for the proliferative region of the intestine in 10 different randomly chosen fields. Mean PCNA labeling across slaughter period was greater (LS mean; $P \leq .03$) for NP compared with PR heifers. Labeling index for NP was greater ($P \leq .05$) at d 120 and 200. The NP heifers had greater ($P \leq .07$) nuclear area at d 40. Nuclear area in NP heifers responded quadratically ($P \leq .07$) over time, while PR heifers responding cubically ($P \leq .01$). The PR heifers had greater ($P \leq .05$) crypt depth at d 200 compared with NP controls. Proliferation of intestinal epithelium is reduced during mid-gestation (d120 and 200) in pregnant heifers which indicates a decrease in tissue metabolism.

Item	Slaughter Period, d						SEM
	0	40	120	200	270	Mean	
PCNA Labeling Index*							
PR	15.2	12.1	11.6	9.7	23.2	13.1	3.4
NP	15.2	11.6	19.7	15.8	21.2	16.7	4.5
SEM	1.6	2.3	1.5	3.1	1.2		
P	.84	.04	.01	.60	.03		
Nuclear Area (μm^2 **)							
PR	23.4	26.5	27.5	24.7	30.1	27.9	3.6
NP	23.4	30.8	26.2	23.5	29.4	26.3	3.1
SEM	1.6	1.2	.7	1.6	.9		
P	.07	.73	.63	.69	.22		

* Values scaled to 1:1,000. ** Treatment x slaughter period interaction ($P \leq .08$).

^aLinear, ^bquadratic, and ^ccubic effects ($p < .10$) within PR or NP across period.

Key Words: Heifers, Pregnancy, Intestinal Cell Proliferation

320 Influence of soybean oil on intake and utilization of mature fescue hay by wethers. R. F. Bapst* and E. S. Vanzant, University of Kentucky, Lexington.

To study effects of soybean oil (SBO) addition to fescue hay diets, fifteen crossbred wethers (Avg BW=33.4kg) were housed in metabolism crates

in an environmentally controlled room, with daytime temperature set at 32C with night cooling. Wethers had ad libitum access to mature, endophyte-infected fescue hay and were randomly assigned to four treatments: Control(C), no SBO; low(L), SBO at 05% of BW; medium(M), SBO at .10% of BW; and high(H), SBO at .15% of BW. Wethers were adapted to diets on d 1-12 and put into crates on d 5. Hay samples and orts were collected and weighed daily on d 13-19. Feces and urine were collected and weighed daily on d 15-21. Rectal temperatures were taken six times daily (0300, 0700, 1100, 1500, 1900, and 2300h) on days 16, 18, and 20. Jugular blood samples were taken on d 1, 14, and 21 and analyzed for prolactin (PRL). Total(TOMI), forage(FOMI), and digestible organic matter intake(DOMI) decreased linearly ($P < .02$) with quadratic trends ($P .18$) as level of SBO increased and averaged 1.79, 1.89, 1.51, and .88% BW for TOMI; 1.80, 1.84, 1.41, and .73% BW for FOMI; and .89, .94, .68, and .36% BW for DOMI. Organic matter digestion(OMD) decreased linearly ($P = .02$) with increasing SBO (49.4, 49.5, 44.3, and 41.6%). Neutral (NDFD) and acid detergent fiber digestion (ADFD) decreased quadratically ($P < .01$) with increasing SBO and averaged 47.4, 47.8, 37.9, and 20.6% for NDFD; and 43.7, 45.4, 35.7, and 14.3% for ADFD. Nitrogen retention (1.6, -6.3, -8.8, and -22.5 g/d) decreased linearly ($P < .01$) with increasing SBO. Rectal temperatures (time x treatment interaction $P = .04$) responded linearly to increasing SBO ($P < .10$) at 0400h and 2000h and were unaffected at other measurement times. Changes in serum PRL levels from d 14 to d 21 responded quadratically ($P < .09$) to increasing SBO and averaged 3, 16, 29, and -1 ng/mL. Results indicate that SBO can be supplemented up to .05% BW without large effects on intake or digestion of mature, endophyte-infected fescue hay by wethers and that dietary lipid may alter PRL response to endophyte.

Key Words: Lipid, Fescue, Ruminant

321 Impact of heating degree days in bermudagrass hay on nutrient digestion by lambs. L. J. McBeth*, K. P. Coffey, W. K. Coblenz, J. E. Turner, D. A. Scarbrough, C. R. Bailey, and M. R. Stivarius, University of Arkansas, Fayetteville.

Spontaneous heating in stored alfalfa hay has reduced forage quality as well as DM and N digestibility. These quality changes are caused by DM losses from microbial respiration in the bale as well as lowered nitrogen availability due to Maillard reactions. The objective of this study was to evaluate the impact of heating degree day (HDD) accumulation in stored bermudagrass hay on nutrient utilization by lambs. Heating degree days were defined as duration and magnitude of heating above 35 C during storage. Twenty Rambouillet wether lambs ($53.1 \pm .74$ kg) were housed in metabolism crates equipped with rubberized, grated floors and collection pans that allowed for total collection of feces and urine. Lambs were stratified by weight and allocated randomly to hays that had previously undergone spontaneous heating, producing either 5, 119, 201, 273, or 401 HDD during a 60-d storage period. Lambs were offered a total of 1.5% of BW of their respective hays in equal feedings at 0700 and 1600 h. A 10-d adaptation to diet and facilities was followed by a 5-d period of total feces and urine collection. Dry matter intake did not differ ($P = .98$) among hays. Linear relationships between digestion characteristics of these hays and HDD were observed; these included apparent DM digestibility ($y = 59.0 - 0.016x$; $P < .01$; $r^2 = 0.37$), NDF digestibility ($y = 66.0 - 0.01x$; $P < .05$; $r^2 = .26$), fecal N excretion (g/d; $y = 37.0 - 0.03x$; $P < .01$; $r^2 = .67$), apparent N digestibility ($y = 44.1 - 0.04x$; $P < .01$; $r^2 = .59$), apparent N digestion (g/d; $y = 29.4 - .025x$; $P < .01$; $r^2 = .44$), N balance (g/d; $y = 22.1 - .02x$; $P < .01$; $r^2 = .31$), and N balance (% of N intake; $y = 33.1 - .036x$; $P < .01$; $r^2 = .43$). Therefore, spontaneous heating during the storage of bermudagrass hay has a negative impact on dry matter and fiber digestion and nitrogen utilization by lambs.

Key Words: Heating Degree Days, Lambs, Bermudagrass

322 Effects of oscillating dietary protein on diet digestibility and nitrogen balance in lambs. T. L. Wechter*, P. A. Ludden, and B. W. Hess, University of Wyoming, Laramie, WY.

Twenty-four wether lambs (avg initial BW = $37.5 \pm .8$ kg) were used in a 64 d randomized complete block design experiment to evaluate the effect of oscillating dietary protein on diet digestibility and N retention. Four treatments consisted of either an 11, 13, or 15% CP diet fed daily, or a regimen in which dietary CP was oscillated between 11 and 15% on a 48-h basis (i.e. 11, 11, 15, 15, 11, 11; ACP). All diets consisted of 65% bromegrass hay (9.0% CP, 61% NDF, 37% ADF) plus 35% corn-based supplement, and were formulated to contain 8.5% of DM as DIP

using a combination of soybean meal and urea. Treatment CP concentrations above 11% were accomplished with the addition of a UIP source (SoyPLUS[®], West Central Cooperative, Ralston, IA). All wethers were fed at 3.0% of initial BW (DM basis) throughout the trial, resulting in an average DMI of 1.14 kg/d across treatments. Nitrogen intakes were 21.3, 26.9, 29.7, and 25.6 g/d for the 11, 13, and 15% CP and ACP treatments, respectively. No treatment effects ($P = .50$) on total tract OM digestibility were observed. Increasing dietary CP from 11 to 15% linearly increased ($P = .0001$) N digestibility from 57.2 to 70.2%. Lambs fed ACP had lower ($P = .06$) total tract N digestibility than those fed 13% CP daily (63.1 vs. 67.2%, respectively). Urinary N excretion increased quadratically ($P = .008$) from 10.4 to 17.8 g/d with increasing CP, thus N retention (g/d) was not influenced ($P = .21$) by increasing dietary CP (1.8, 3.0, and 3.1 g/d for the 11, 13, and 15% CP treatments, respectively). Nitrogen retention of lambs fed ACP (1.5 g/d) tended to be lower ($P = .18$) than for lambs fed 13% CP daily. As a percentage of digested N, N retention did not differ across treatments, but was numerically lower ($P = .30$) for lambs fed ACP compared to those fed 13% CP daily (9.0 vs 15.4% of digested N, respectively). Oscillating dietary CP concentrations may have negative effects on N metabolism of growing lambs, which appears to be associated with decreased post-absorptive utilization of digested protein.

Key Words: Protein, Nitrogen retention, Sheep

323 Effects of feeding corn vs. casein in concentrated rations on flux of nitrogenous compounds across the PDV. M. B. McDonagh*, H. C. Freetly, and C. L. Ferrell, *USDA, Meat Animal Research Center, Clay Center, NE.*

This experiment compared the flux of nitrogenous compounds across the portal-drained viscera (PDV) in 7 growing lambs (25.9 ± 3.3 kg) fed concentrated rations in a incomplete latin square design. The rations were one level of unbalanced protein intake (corn, corn gluten and urea with alfalfa) or three different levels of balanced protein intake (casein with cornstarch, solka floc and molasses). Lambs were estimated to require 205g/d protein for rapid growth. Rations were fed at equal amounts and equal energy content in three-week blocks, after which PDV measurements were taken. Random effects were actual crude protein intake by ration and ration by sampling time. Neither ration protein level nor type influenced average daily gain over the experimental periods ($P = .25$). Across the PDV, no difference was seen in blood flow ($P = .99$) or oxygen consumption ($P = .84$) between rations, suggesting that energy use by the PDV did not differ. Flux of alpha-amino nitrogen (AAN; $P < .01$) and NH_3 ($P < .01$) across the PDV was highest for the corn based ration. No effect of ration was observed for urea flux ($P = .36$). Although amount of protein offered differed by 60% between casein based rations, no difference was seen in flux of AAN across casein levels. This disparity between feed protein level and observed AAN flux for casein diets could be explained by observed crude protein intake over the sampling period. Overall, there was no significant effect ($P = .19$) of protein intake or type on total flux of nitrogenous compounds across the PDV.

325 Curriculum review for the department of animal sciences (ANSC). M.A. Diekman* and J.D. Armstrong, *Purdue University, West Lafayette, IN/USA.*

A 16-month undergraduate curricular review was conducted by the Department of ANSC and changes were implemented for the fall semester, 1999. Input for the review was obtained through alumni and industry surveys, student entrance profiles, senior exit interviews, veterinary student surveys, faculty retreats, cooperating departments in the Schools of Agriculture and Veterinary Medicine at Purdue, and a review of animal, dairy and poultry sciences departments of sister institutions considered to be primary, secondary or tertiary competitors. Of these inputs, senior exit interviews appeared to be the most valuable. From these interviews during the spring semesters of 1998 and 1999 ($n = 100$), 9.1% of ANSC majors entered agribusiness option, 67.3% entered science option, 14.7% entered production option, 1.8% entered products option and 7.1% transferred from other departments or universities. Approximately 50% of the students in the science option had pre-vet interest. At graduation, 30.8% of students were in agribusiness, 44.2% in science, and 25.0% in production. Placement of students graduating with BS in ANSC were 27.8% business/industry, 11.1% family operation,

	Corn 205g/d	Casein 150g/d	Casein 205g/d	Casein 250g/d	SEM
CP intake (g)	222	119	111	120	4.9
Av. daily gain (g)	287.7	156.7	161.2	169.3	38.6
Blood flow (L/hr)	156.2	154.1	151.6	151.3	17.6
O ₂ flux*	230.5	200.7	221.9	201.5	27.2
AAN flux*	72.4	29.7	35.7	40.0	5.4
Urea flux*	-18.9	-10.8	-7.8	-20.5	5.8
NH ₃ flux*	48.7	18.4	27.7	28.6	3.5
Total N flux*	84.6	26.3	44.8	33.6	14.3

* Flux values are in mmol/hr

Key Words: Nitrogen flux, Portal drained viscera, Sheep

324 Intestinal cellular proliferation in sheep consuming low-quality forage or high concentrate diets. J. S. Caton*, K. C. Swanson, A. N. Scheaffer, M. L. Bauer, and L. P. Reynolds, *North Dakota State University, Fargo.*

In Exp. 1, 20 mature ewes (63 5.4 kg) were fed a 6.6% CP grass hay:straw diet and one of four supplemental treatments. Treatments were control (no supplement), low (5.2), medium (22.1), and high (41.3%) UIP. After 42 to 46 d, ewes were infused i.v. with 5-bromo-2-deoxy-uridine (BrdU; a thymidine analog) and slaughtered 1 h later. In Exp. 2, 24 black-faced, crossbred wether lambs (32 6.1 kg) were assigned to one of four treatments. Treatments were a pelleted diet (80% concentrate) at low (60% of ad libitum) or high intake (95% of ad libitum). Diets either contained (40 mg/d) or did not contain lasalocid. After 42 to 45 d, lambs were slaughtered. In Exp. 2, proliferating cell nuclear antigen (PCNA) was used to estimate cellular proliferation. In both studies, samples of duodenum, jejunum, ileum, cecum, and colon were prepared for immunohistochemical analysis. Data were analyzed for effects between tissue sampling site. Means were separated using contrasts. Treatment effects were previously reported. In Exp. 1, area of BrdU labeling was greater ($P < .01$) in small (1138) vs large intestines (528 m²). Within the small intestine, BrdU labeling was lower in duodenum, compared with jejunum and ileum ($P < .01$; 961 vs 1226 m², respectively). Crypts were deeper ($P < .01$) and villi longer ($P < .01$) in duodenal compared with jejunal and ileal mucosa (220 vs 179 m; 525 vs 439 m, respectively). In Exp. 2, area of PCNA labeling was greater ($P < .01$) in the small intestine (1729) vs large intestine (807 m²) and greater ($P < .01$) in duodenum (1937) compared with jejunum and ileum (1625 m²). Deeper crypts and narrower villi were found in jejunum compared with ileum ($P < .01$; 228 vs 257 m; 110 vs 126 m, respectively). Data indicate cellular proliferation is greater in small vs large intestine in ewes fed low-quality forage and wethers fed concentrate diets. However, within the small intestine, region of greatest cellular proliferation differed between studies.

Key Words: Sheep, Intestine, Cell Proliferation

TEACHING

18.5% graduate school, 5.6% production, 27.8% veterinary school and 9.8% other. In the four options listed above, each required and elective course was evaluated. Agribusiness, production and products options were modified slightly, but a pre-veterinary and biotechnology specialization were added to the science option. Specializations and/or options in animal behavior/well-being, food product business, companion, zoo, and lab animal were not adopted. Courses in biology of companion animals and companion animal management were added and opportunities for internships were strengthened. Other concerns were handled by newly adopted minors in other departments in the School of Agriculture effective January 1, 2000. Modernization of the curriculum should be more attractive to non-traditional animal science students and provide training for careers in the animal industry in addition to the domestic farm animals.

Key Words: Curriculum, Animal sciences, Options

326 Implementation of an interdisciplinary grazing livestock systems major. D. R. Brink*, L. E. Moser, W. H. Schacht, J. A. Gosey, and G. H. Pfeiffer, *University of Nebraska, Lincoln, NE.*

A Grazing Livestock Systems (GAS) major was developed to provide a major that emphasizes integration of animal science, forage and range science and agricultural economics. The GAS major is designed for students whose career interests involve management of livestock utilizing forage, pasture, and range as the principal feed resource. The program of study allows specialization in ruminant livestock, forage and range management or economics while maintaining the systems orientation of the major. A detailed description of the curriculum and related information may be found at <http://www.ianr.unl.edu/ianr/cgs/glsmdat.htm>. Successful graduates of GAS will likely pursue careers as managers of livestock farms or ranches, or in public and private sector positions that assist in the management, education and support of grazing livestock decision making. The major requires a structured 13 week internship. Students will be advised by an individual faculty member working with an interdisciplinary faculty team to coordinate course and internship selection. The internship requires a pre-internship planning seminar, approval by an interdisciplinary internship committee, and a post-internship seminar presentation and written report. Administration of the major is by the Center for Grassland Studies (CGS). An advisory board of stakeholders (organized by CGS) from the ranching community, public agencies, and agribusiness, contributed to the development of the major. A stakeholders group will guide the development and maintenance of the internship program, as well as, the GAS major as a whole. The major has been strongly endorsed by clientele, students and university administration. A Cooperative, State, Research, Education and Extension Service grant was awarded to support the implementation of the GAS major. The implementation process of the GAS major provides experiences related to interdisciplinary faculty cooperation, involving clientele, and structure of internships which may be useful in providing additional interdisciplinary majors.

Key Words: Grazing, Livestock, Teaching

327 Effects of college major on student acceptance of animal utilization by humans, and perceptions about ethics, welfare, and food safety in animal agriculture. R. D. Pinckney, L. Backstrom*, and V. D. Leibbrandt, *University of Wisconsin-Madison, Madison, WI/U.S.A.*

During September 1999, a survey was conducted at the University of Wisconsin-Madison to determine whether animal science (A; n = 56), non-agriculture (N; n = 102) and veterinary (V; n = 83) students differ in acceptance of using animals in medical research and foods, perceptions about husbandry methods, ethics and animal welfare, and food safety in animal agriculture. Questionnaires were similar across student groups, with additional questions about species and career interest for animal science and veterinary students. The response range was 1 = strong interest/support/very adequate, to 4 = no interest/strongly oppose/not adequate at all. A separate option was "no opinion/don't know". Data entry and processing were provided by WI Survey Research Lab. Chi square analysis was used to evaluate college major effects. The A students were more strongly supportive of the use of animals in medical research (89%) than the N (71%) and V (71%) students ($p < .05$). There were no consistent differences between student groups on eating choices ($p > .05$). The percentages of A, N and V students supporting stanchion/stall/cage rearing systems were, respectively, 66, 23, 48% for dairy cows; 25, 10, 14% for veal; 45, 14, 25% for sows, and 41, 16, 26% for lay hens (college major, $p < .05$). Support for use of the intensifying industrialization of the swine industry across majors was low: 25% (A); 10% (N); 20% (V) ($p < .001$). Positive perceptions about pre-harvest food safety conditions also differed between groups: 68% (A); 33% (N); 54% (V) ($p < .001$). Support for use of antibiotics, hormone implants, and genetic engineering among groups was $A > V > N$ ($p < .001$). Overall, college major affected student acceptance and perceptions about animal agriculture, use of animals in medical research, but did not affect eating choices.

Key Words: college students, perceptions, animal agriculture

328 Meat judging as a learning tool. P. T. Berg¹ and A. N. Scheaffer*, *North Dakota State University.*

Meat judging contests are divided into eight categories: Judging (beef, pork, & lamb); Grading (quality & yield); placing classes; reasons and specifications. Individual (N=1801) results in five meat judging contests from 1993 through 1998 were analyzed to assess student learning. Generally, point totals increased from contest 1 through contest 4 and declined for contest 5 indicating learning is taking place in spite of planned increased contest difficulty. Relative difficulty is better assessed by converting each student's categorical points to a percentage (%) of the total that individual earned. Chi-square (χ^2) values were calculated using the student's % score as the OBS and the formatted % for each category as the EXP. Student numbers vary between contests, thus χ^2 was converted to an average ($A\chi^2$) for comparison. Decreasing $A\chi^2$ indicates students are in closer agreement with the OC. Generally, contest 1 $A\chi^2$ values are lower than the next 3 contests indicating a straight forward approach to classes in contest 1. Contest 2 - 4 show a steady decline in $A\chi^2$ for 5 of the 8 categories. Contest 5 $A\chi^2$ were higher than for the contest 4 in 6 of the 8 categories illustrating the relative difficulty of the final contest. Because of the differences in training programs among the universities a sub-sample, those individuals who participated in contests 1, 4 & 5 were identified (n=105). $A\chi^2$ among these students varied between universities but declined from contest 1 - 5 in 5 of the 8 categories. $A\chi^2$ values were lower within the sub-sample compared to the general group. To test whether the learning curve found in the judging environment was extended to the classroom, the cumulative grade point average of NDSU meat judging students (JT) was compared to a random sample (RS) of non-judging team ARS students (JT n=93 vs RS n=54). Both groups GPA increased from FR to SR (2.77 to 2.96; $P=.03$). Completing the FR year, JT students GPA=2.79 vs RS=2.75 ($P=.66$). JT students GPA increased to 3.01 as SR ($P<.01$) while RS students increased to 2.87 ($P=.22$). As SR JT GPA=3.01 vs RS GPA=2.87 ($P=.09$). This analysis indicates learning continues over the contest year and is carried into the classroom.

Key Words: Meat Judging, Learning

329 Industry expectations of undergraduate and post-graduate meat science curriculum. C. L. Lorenzen*¹, E. P. Berg², and A. D. Clarke¹, ¹*Food Science and Engineering Unit*, ²*Animal Science Unit, University of Missouri-Columbia.*

A survey was sent out to 11 companies in the meat industry in order to assess the educational needs of meat science students at the undergraduate and graduate level. Ten of the companies (90.9%) returned the survey. The goal of the survey was to determine professional skills and meat science knowledge important at the bachelor, master, and doctoral level for University of Missouri graduates to be competitive in an industry setting. Communication skills and professional appearance followed by commitment and work ethic were the most frequently mentioned skills that influenced a hiring decision. Other skills mentioned more than once were: meat industry experience and knowledge, reasoning skills, attitude, advanced computer proficiency, ability to grow with the company, ability to handle multiple priorities, leadership, willingness to learn new things, and adaptability to different situations. For all educational levels, the essential areas of knowledge most frequently cited were meat science, advancing with each degree, followed by food safety. Other areas of knowledge mentioned more than once at the advanced degree level were: project design and statistical analysis, sensory evaluation skills, meat and further processing skills, and management skills. The survey results are an important step to rebuilding the meat science curriculum at the University of Missouri. These results emphasize the importance of written and oral reports in class as well as undergraduate meat industry internships. Recommendations for post-graduate curriculum highlighted the importance of a well-rounded meat science background. Providing the graduate with experience in handling a variety of situations is also critical to their success. The results also indicate a need to evaluate coursework, such as business courses, that are not typically included in a traditional meat science program.

Key Words: Education, Meat Science, Survey