for only 50% of HS-induced decreases in milk yield and, based upon glucose challenge and basal NEFA data, increased extra-mammary insulin sensitivity may contribute to the additional reduction in milk yield.

Key Words: Glucose homeostasis, Heat stress, rbST

Production, Management and the Environment II

395 Incorporating environmental compliance costs into livestock diet formulation. J. C. Hadrich, C. A. Wolf*, and S. B. Harsh, *Michigan State University*, *East Lansing*.

The current method to derive livestock diets is to minimize cost subject to animal performance and nutritional requirements that the performance level dictates. This approach allows nutritionists and farm managers to make livestock diet decisions based on the prices of alternative feed products. This method explicitly ignores the cost of over-feeding protein and minerals which must be disposed of with animal waste. Environmental compliance is a primary concern on livestock operations which must consider farm, and field, levels of phosphorus and nitrogen. Actual compliance costs are individual to the farm situation and depend on land availability, animal density, waste management methods, and feeding practices, among other factors. However, environmental compliance costs are significant on many farms and the feeding decision is a major source of nutrient import onto the farm. We reconsider livestock diet formulation to determine the cost effective diet using environmental compliance goals and resulting costs unique to the farm. A penalty function is incorporated in the feed cost minimization decision. Farm characteristics that influence this penalty function are animal density, amount of phosphorus (P) fed to the animals, cropping program, application of commercial fertilizers, land availability for manure application, current soil P levels and distance manure is hauled. Including the nutrient penalty function the ration formulation reallocates diet ingredients to accommodate lower levels of P in the ration. In the short run it may increase the ration costs, but simultaneously decreases the amount of by-product in the ration which may lead to cost savings when the total cost of nutrients are considered. With the increasing availability of by-product feeds, producers must be aware of the total cost rather than the input cost of feedstuffs. Incorporating nitrogen levels and alternative nutrient management strategies are ongoing.

Key Words: Diet cost, Environmental compliance

396 Development and integration of a national feed management education program and assessment tools into a comprehensive nutrient management plan. J. H. Harrison[1], R. A. White*[1], T. J. Applegate[2], R. T. Burns[3], G. H. Carpenter[4], G. E. Erickson[5], and A. L. Sutton[2], [1]*Washington State University*, *Puyallup*, [2]*Purdue University*, *West Lafayette, IN*, [3]*Iowa State University*, *Ames*, [4]*USDA, NRCS*, *Beltsville, MD*, [5]*University of Nebraska*, *Lincoln*.

In 2003, the US Environmental Protection Agency (EPA) released new guidelines for Concentrated Animal Feeding Operations (CAFO). Under the new guidelines, permitted CAFOs will be required to develop a Nutrient Management Plan (NMP). In most cases, with minor additions, a USDA, Natural Resources Conservation Service (NRCS) Comprehensive Nutrient Management Plan (CNMP) will satisfy the requirements of an NMP. One of the Core Elements of the CNMP is feed management. In 2005, a national feed management education project was funded by the NRCS Conservation Innovation Grant program (CIG). The project will develop, test, and implement a National Feed Management Education Program and Assessment Tools into a Comprehensive Nutrient Management Plan. The goal of the project is to increase the understanding of feed management to agricultural professionals, with an emphasis on environmental and financial sustainability of livestock and poultry operations. A team consisting of consulting animal nutritionists, technical service providers (TSPs), Extension Specialists, and research scientists will accomplish the following program objectives: 1) develop and evaluate a two-tier tool for assessing the impacts of feed management practices on whole farm nutrient balance for animal nutritionists, NRCS staff and TSP advisors, 2) develop the content of a Feed Management chapter for the NRCS Agricultural Waste Management Field Handbook (AWMFH), and 3) develop and implement an education program targeting integration of feed management into a CNMP. Specific outcomes are: 1) develop educational materials that are applicable at the national level, 2) provide training for NRCS staff, agricultural professionals, and TSPs in feed management concepts and practices that minimize import of nutrients to the farm, 3) provide training in the use of computer models and software for strategic ration balancing, whole farm nutrient balance, and nutrient excretion estimates based upon feed and animal performance inputs, and 4) develop a chapter for the NRCS AWMFH on Feed Management.

Key Words: Feed management, Nutrient management, Environment

397 Decision support model of nutrient excretion in beef feedlots. C. B. Williams* and T. G. Jenkins, *USDA, ARS, U.S. Meat Animal Research Center*, *Clay Center, NE*.

Component biological models were developed at the U.S. Meat Animal Research Center to partition ME and protein intake to maintenance and gain, and partition protein and ME for gain to fat and protein accretion in growing and mature cattle. These models were integrated with a life cycle beef production model reported by Colorado State University, and phosphorus and potassium intake and utilization functions were added. Evaluations with independent sets of experimental data documented that the beef life cycle model could accurately predict responses under different levels of nutritional management. This model represents a nutrient utilization model for ME, nitrogen, phosphorus and potassium, and it was integrated with the nutrient supply model of the Cornell Net Carbohydrate Protein System to predict nutrient supply. Nutrient excretion was predicted as the difference between supply and utilization. Use of the biological model requires knowledge of computer programming, therefore a graphical user interface consisting of easy to use screens was developed to simplify data input and make the biological model more accessible to producers and professional animal scientists. The software package provides an easy to use decision support tool that predicts nitrogen, phosphorus, and potassium excretion in beef feedlots, in response to breed, management, and different dietary formulations.

Key Words: Beef cattle, Computer simulation, Decision support

398 Maximized lactational performance for improving postweaning reproductive performance on commercial farms. Y. Tanaka* and Y. Koketsu, *Meiji University*, *Kawasaki, Kanagawa, Japan*.

The objectives in this study were to study lactational performance across parities; associations between lactational performance and postweaning reproductive performance; and correlations of three lactational performances between consecutive parities. The three performances were weaning litter weight (WLWt), average pig weight at weaning (PIGWt), and number of pigs weaned (PW). This cohort study over 6 yr was conducted by using 94 farms containing 66,239 weaned records of 14,140 females born during 1999. Five groups of PW were formed on the basis of 5, 25, 75, and 95 percentiles of sows: ≤ 6, 7 - 8, 9 - 10, 11, and ≥ 12 pigs. Three groups of WLWt were formed on the basis of upper and lower 25 percentile of sows: ≤ 48.0, 48.0 - 70.0, and ≥ 70.0 kg. Pearson correlation analysis and partial correlation analysis using PW as a controlled variable were done. Mixed models were used to analyze the associations between farrowing rate, weaning-to-first-mating interval, and lactational performance. Across parities, the means of PW ranged from 8.9 to 9.7 pigs. The means of WLWt across parities ranged from 56.3 to 61.6 kg, and the heaviest WLWt was found at parity 2 and 3 ($P < 0.05$). The correlations were found between consecutive parities from 1 to 6 in WLWt and PIGWt ($0.38 \leq r \leq 0.56$; $P < 0.05$). Sows with PW ≤ 6 pigs had the longest weaning-to-first-mating intervals among the PW groups ($P < 0.05$). No differences in weaning-to-first-mating intervals were found in the PW ≥ 7 pigs groups. Sows with PW 9 - 10, 11, and ≥ 12 pigs had higher farrowing rates than those with PW ≤ 8 pigs ($P < 0.05$). Sows with WLWt ≥ 70.0 kg had the highest farrowing rate ($P < 0.05$), and had weaning-to-first-mating intervals similar to those with WLWt < 70.0 kg. Sows with PW 9 - 10 pigs had an approximately 100 g heavier PIGWt than those with PW 11 pigs ($P < 0.05$). Maximized WLWt with PW ≥ 9 pigs did not impair farrowing rates and weaning-to-first-mating intervals. High correlations in WLWt indicated that sows with heavy WLWt were more likely to be productive at subsequent parity.

Key Words: Management, Sows

399 Effect of parity and rearing segregation at birth on productive performance and health status of pigs. C. Pineiro*[1], J. Morales[1], G. G. Mateos[2], and X. Manteca[3], [1]*PigCHAMP Pro Europa, S.A.*, *Segovia, Spain*, [2]*U.P. Madrid*, *Spain*, [3]*U.A. Barcelona*, *Spain*.

Progeny of primiparous sows (GIL) have lower birth weights, higher mortality and poorer performance than the progeny from multiparous sows (SOW). The reason is unknown but might be related to differences in colostrum quality. To confirm this hypothesis a total of 10 GIL and 10 SOW (3rd to 5th parturition) were selected from a group of 100 sows. Half of the piglets of each sow were reared by its own mother whereas the other half was fostered off to the other group of sows before colostrum intake. Therefore, there were four treatments arranged factorially with two types of sows (GIL vs SOW) and two rearing systems (GIL-R, reared with gilts or SOW-R, reared with multiparous sows). Average daily gain (ADG), feed intake and feed efficiency were controlled and blood sampled at 14, 28, 40, 60, 90, 116, and 142 d of age to analyse the concentration of Pig-MAP, an acute-phase protein used as biomarker of health status. At the end of the trial pigs born from GIL ate less feed (1592 vs 1436 g/d; $P<0.01$) and grew less (605 vs 669 g/d; $P<0.001$) than pigs born from SOW. Also, pigs GIL-R grew less (621 vs 653 g/d; $P<0.05$) and were less efficient (2.63 vs 2.39 g/g; $P<0.001$) than pigs SOW-R. An interesting interaction occurred for ADG from 88 to 116 d of life; GIL-R pigs grew less than SOW-R ($P<0.01$) only if they came from GIL. At 146 d of age BW was higher for SOW than for GIL pigs (87.0 vs 79.1 kg; $P>0.001$) and for SOW-R than for GIL-R pigs (85.1 vs 81.0 kg; $P<0.05$). During the fattening period mortality was higher for GIL-R pigs (9.2 vs 2.1%; $P<0.05$) suggesting that the quality of the colostrum ingested influences health status. In association with these results, Pig-MAP serum concentration was higher in GIL-R pigs (0.70 vs 0.86 mg/ml; $P<0.05$). An interaction was found at 116 d of life for this biomarker; GIL-R pigs from GIL had higher serum levels than the others ($P=0.09$). We conclude that both age of the sow and type of rearing after birth affect weaning performance and mortality during the whole rearing period.

Key Words: Pig, Primiparous, Performance

400 Effect of mixing pigs or maintaining pen integrity on the response to grow-finish space allocation. R. Goodband[1], M. Brumm*[2], L. Johnston[3], and K. Stalder[4], [1]*Kansas State University*, *Manhattan*, [2]*University of Nebraska*, *Lincoln*, [3]*University of Minnesota*, *St. Paul*, [4]*Iowa State University*, *Ames*.

Recent NCR-89 data (JAS, 79:1967-1972) indicated that when pigs are mixed into new social groups following the nursery phase, space restrictions during the finishing phase decrease ADFI and ADG. However, in a second study, when the social group remained intact, space restrictions during finishing had no effect. Therefore, a cooperative study using 906 pigs was conducted to evaluate either mixing pigs or maintaining pen integrity during the move from nursery to finishing and its effect on finishing space allowance. Treatments were arranged in a 2 × 2 factorial with main effects of mixing or maintaining pen integrity as pigs were moved to finishing facilities (BW 24.9 kg) and providing either 0.56 or 0.74 m2 per pig. There were 8 pens per block and 7 blocks. In 2 pens, pen integrity was maintained and pens were allocated to either 0.56 or 0.74 m2 per pig. For mixed treatments, pigs from 3 pens were mixed into 3 new pens and assigned to 0.56 m2 per pig. Likewise, 3 more pens were mixed and assigned to 0.74 m2 per pig. Individual pen was the experimental unit. From d 0 to 14, no treatment effects were observed ($P = 0.07$). For the overall data, there was no interaction between maintaining pen integrity or not and space allocation ($P = 0.13$) for ADG or ADFI. Maintaining pen integrity did not affect ADG or ADFI compared with mixing pigs (0.87 and 2.37 vs. 0.87 and 2.36 kg/d, respectively). However, pigs provided 0.56 m2 had decreased ADG and ADFI compared with those provided 0.74 m2 (0.86 and 2.34 vs. 0.88 and 2.39 kg/d, respectively). When providing 0.56 m2 per pig, mixed pigs had better G:F compared to unmixed pens, but poorer G:F than unmixed pens when 0.74 m2 per pig was provided (interaction, $P = 0.04$). These results confirm expected reductions in growth and feed intake of pigs restricted in space. In this study, maintaining pen integrity when moving pigs from nursery to finishing facilities had no beneficial effect on pig performance.

Key Words: Mixing, Pigs, Space

401 Influence of thymol on coliform bacteria, VFA, and methane production from pull-plug swine manure pits. V. H. Varel* and J. E. Wells, *USDA, ARS, U.S. Meat Animal Research Center*, *Clay Center, NE*.

This study was conducted in swine manure pits to determine the influence of thymol addition on pathogen, odor, and methane emission. Two experiments were conducted in 2 pull-plug pits (34,000 L each) which had partially slotted floors with 6 pens (16 sows per pen) over

each pit. One pit served as the control and the other pit was amended with approximately 1.5 and 3.0 g of thymol/L in experiment 1 and 2, respectively. Each experiment lasted 18 d, during which time five to six 200 ml samples were withdrawn from underneath each pen and analyzed for DM, thymol, VFA, and coliform bacteria. At the end of each experiment, 50 g samples, 6 from each pit, were placed in 200 ml serum bottles and gas volume and composition were determined periodically for 28 d. The slurry DM was not affected by thymol treatment in either experiment. Compared to the control pit, VFA production was reduced 1.28 and 1.71 mmoles/L d^{-1} (65 and 100%) for thymol amendments of 1.5 and 3.0 g/L, respectively ($P < 0.01$). Coliform and *Escherichia coli* viable cells were reduced 1.55 and 1.76 $\log_{10}$ CFU/g slurry for the 1.5 g of thymol/L treatment, respectively; and 2.73 and 2.94 $\log_{10}$ CFU/g slurry for the 3.0 g of thymol/L treatment, respectively. Total gas production from the serum bottles was reduced 64 and 76% for thymol amendments of 1.5 and 3.0 g/L, respectively ($P < 0.01$); and methane production was reduced 77 and 93%, respectively ($P < 0.01$). These results suggest that thymol may be useful in swine production facilities equipped with slotted floor manure pits to reduce pathogens, odor, and greenhouse gas.

Key Words: Swine manure, Odor, Pathogens

Ruminant Nutrition: Fat Feeding, Metabolism & Composition

402 Artificial neural networks to model the rumen fermentation pattern in dairy cattle. M. Craninx, B. Vlaeminck, and V. Fievez*, *Ghent University*, *Melle, Belgium*.

The aim of this study is a preliminary evaluation of the use of an artificial neural network (ANN) to predict rumen molar proportions of volatile fatty acids from milk fatty acids. The current study combined data from ten experiments with rumen fistulated dairy cows, resulting in a dataset of 138 observations, which were split into a training (n=93), a validation (n=10) and a test (n=35) set, with the former used to iteratively train the model until the minimal mean square prediction error of the validation set was reached and the latter to independently test the model. A similar distribution of the input and output variables in both data sets was ensured. Essential data-input pre-processing prior to ANN model development included normalisation in the [-1 1] interval and reduction of the number of variables by selecting mutual uncorrelated milk fatty acids, based on correlation and principal component analysis and by excluding milk fatty acids of dietary (e.g. C18:2n-6 and C18:3n-3) or multiple origin (e.g. cis 9 C18:1), based on background physiological knowledge. Different types of ANN architecture and training algorithms were evaluated and the final neural network was characterised by 1 hidden layer with 12 neurons and a Scaled Conjugate Gradient training algorithm. The selected input variables included the milk odd and branched-chain fatty acids, which are directly derived from rumen microbes and biohydrogenation intermediates, which accumulate to a different extent according to rumen conditions. The regression between the observed and predicted values showed similar results for training and test data, suggesting no overfitting. The evaluation on the test data showed determination coefficients of 0.801, 0.686 and 0.541 and a relative root mean square prediction error of 2.64%, 9.47 % and 8.64% of the observed mean for acetate, propionate and butyrate, respectively. The results suggest that ANN is a potential method to predict molar proportions of volatile fatty acids in the rumen.

Key Words: Modelling, Rumen fermentation, Milk fatty acids

403 ^{13}C Enrichment of conjugated linoleic acids and other fatty acids in cultures of ruminal microorganisms dosed with a stable isotope of linoleic acid. C. Thompson, J. Mulz, M. Reynolds, E. Thies, and T. Jenkins*, *Clemson University*, *Clemson, SC*.

Most published accounts of linoleic acid biohydrogenation by ruminal microorganisms account for only a single C18:2 intermediate, namely the *cis*-9, *trans*-11 conjugated linoleic acid (CLA) isomer, prior to its complete hydrogenation to stearic acid. The purpose of this study was to determine the full range of C18:2 intermediates arising from the biohydrogenation of linoleic acid. Six rumen in vitro cultures were run, with half of the cultures receiving 25 mg of unlabelled linoleic acid in 1 mL of ethanol and the other half receiving 25 mg U-^{13}C-linoleic acid in ethanol injected at the start of incubation. Samples were taken from each flask at 0, 6, 24, and 48 hours. Methyl esters of fatty acids were separated on a 100-m CP-Sil 88 column and abundances of the quasimolecular ion (M) and M+18 ion were determined by mass spectroscopy in positive chemical ionization mode. Enrichment (M+18/M minus background) data greater than zero were determined by t-test when $P > 0.05$, and time effects were analyzed by ANOVA. Enrichment of linoleic acid in the culture contents at 0 h was 0.32, which increased to 1.29 ($P < 0.05$) by 48 h. Enrichments at 48 h were 0.06, 0.08 and 0.22 for stearic acid, *trans*-11 C18:1, and *cis*-9, *trans*-11 CLA, respectively. Higher enrichments were observed for the *trans*-10, *cis*-12 CLA (1.33) and *trans*-9, *trans*-11 CLA (1.12) isomers by 48 h. Two additional peaks in the CLA region were enriched (0.99 and 0.87) but not identified. The increasing enrichment of linoleic acid over time suggests preferential utilization of the unlabelled compound for biohydrogenation, which was consistent with low enrichment for stearic acid. High enrichments that increase over time, such as those seen for several CLA, might indicate conversion from the labeled linoleic acid via a nonenzymatic isomerization process.

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Key Words: Biohydrogenation, Linoleic acid, Rumen

404 The effect of fish oil supplementation on ruminal C18 PUFA metabolism in beef steers offered either grass or red clover silage. M. R. F. Lee*[1], K. J. Shingfield[2], and N. D. Scollan[1], [1]*Institute of Grassland and Environmental Research*, *Aberystwyth, Ceredigion, UK*, [2]*MTT Agrifood Research*, *Jokioinen, Finland*.

Red clover and fish oil have been shown to alter ruminal lipid metabolism increasing PUFA and conjugated linoleic acid (CLA), respectively, in ruminant products. This study investigated the additive effect of these two feeds on C18 PUFA metabolism in beef steers. Eight Hereford × Friesian steers prepared with rumen and duodenal cannulae were offered either grass or red clover silage at 90% ad libitum with one of three levels of fish oil 0, 1, 2, or 3 % DMI. The experimental design consisted of four 2 × 2 Latin squares within each