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

Based on applications of the 1996 NRC (Nutrient Requirements of Beef Cattle, 2000 update) model at our laboratories and in using the model to evaluate published literature, it is our assessment that the NRC model (Level 1) is a major advancement for nutrition and management for grazing cattle. We have demonstrated that the NRC model is useful in developing hypotheses, determining nutrient status, identifying limiting nutrients and needed inputs, and in evaluating published research. The NRC model gives reliable and useful estimates of gains in body weight and/or body condition score and forage intake of beef cattle. From estimated forage intake and performance, effective supplement and/or management practices can be developed and experimental outcomes evaluated. Because of the difficulties associated with measuring forage intake by grazing cattle, the high variability that exist between reports of forage intake within and between classes of grazing cattle, and the impracticality of measuring intake in production settings, the NRC model is a significant improvement in resources available to managers and researchers for estimating forage intake and determining nutrient needs of grazing cattle. The model is useful for evaluating nutritional scenarios (i.e. what if?) related to the nutrient needs of the cow, nutrient content of forages and need for supplemental nutrients. For example, effects of physiological status of the cow at a given point or throughout the year could be evaluated and factors such as calving or weaning date could then be adjusted to fit low or high quality forages. Model adjustments for cold environments and grazing activity appear to overestimate maintenance requirements. The key to application of the model for research or production is reliable description of the nutrient composition of cattle diets. Descriptions of cattle diets for a broad range of grazed forages are needed or need to be made more readily available to users of the model.

**Key Words:** Intake, NRC, Cattle

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

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

**Key Words:** Metabolizable Protein, Range, Cattle

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

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

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

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

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

**Key Words:** Forage Intake, Forage Quality, Beef Cattle

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

Designing a sound nutritional program for cow-calf operations requires knowledge of the animal's nutrient requirements, diet quality, and intake. Effectively using the 1996 NRC Beef Cattle Requirements model

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

**Key Words:** Cattle, Protein, Requirements

### 47 Rumen-stable choline for transition dairy cows.

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

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

**Key Words:** Choline, Rumen-Stable, Transition Cow

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

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

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

**Key Words:** Extension, Pork, Quality

### 49 Using heart girth to estimate weight in finishing pigs.

C.N Groesbeck*, R.D. Goodband, J.M. DeRouchey, M.D. Tokach, S.S. Dritz, J.L. Nelssen, K.R. Lawrence, and M.G. Young, *Kansas State University, Manhattan*.

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

**Key Words:** Heart Girth, Finishing Pigs, Swine

### 50 Development of a stochastic pig compositional growth model.

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

A stochastic pig compositional growth model was developed using mixed model nonlinear functions. Serial body weight (BW) measurements were fitted to mixed model nonlinear equations with three parameters and two random effects. The best model for BW based on Akaike's Information Criteria (AIC) values was $BW_{it} = (C + c_i)$ (1 x exp (-exp $(M' + m'_i)$ $t^A)$) + birth weight + $e_{it}$, where C, M', and A are fixed population

mean parameters; $c_i$ and $m'_i$ are random effects for the $i^{th}$ pig; t is days of age; birth weight is a constant (1.4 kg); and $e_{it}$ is the residual error. Empty body protein mass (EBPRO) data were predicted from serial real-time ultrasound and BW measurements. Predicted EBPRO data were fit to a nonlinear function of BW with one random effect: EBPRO = C $(f(\text{BW}))$ + $cp_i$ $(f(\text{BW}))^D$, where $f(\text{BW})$ = (1 x exp ($b_0$ + $b_1$ BW + $b_2$ $(\text{BW})^2$), C and D are fixed parameters, and $cp_i$ is a random effect. The value of D, 1.895 (SE = 0.09) indicates the between pig variation of empty body protein mass percentage increases as empty body protein or BW increase. The model accounts for the relationship among the random effects for BW growth and $cp_i$. Daily lipid accretion was predicted from genetic population-sex specific relationships between BW, EBPRO, and empty body lipid mass: empty body weight = 0.93 BW; and empty body weight = $a_1$ $(\text{EBPRO})^b 1$ + $a_2$ (empty body lipid mass)$^b 2$. The model predicts a pig specific BW growth curve and daily compositional growth rate for carcass fat-free lean, carcass fat tissue, EBPRO, and empty body lipid. Carcass measurements were predicted as functions of carcass weight, fat-free lean or carcass fat tissue mass, sex, and carcass fat-free lean or fat tissue percentage. To reproduce the total variation in compositional growth, the residual variance of each variable was produced by multiplying the residual standard deviation of each prediction equation by a value sampled from a standard normal distribution. The stochastic model can be used to develop strategies to target a specified mean and distribution of carcass weight and composition.

**Key Words:** Pig, Stochastic, Growth Model

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

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

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

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

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

**Key Words:** Pigs, Ractopamine, Economic Analysis

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

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

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

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

G = Gilt, B = Barrow.

**Key Words:** Ractopamine, Pig Growth Model, Economic Analysis

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

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

**Key Words:** Swine, Ultrasound, Certification

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

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

**Key Words:** Pigs, Education

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

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

**Key Words:** Beef Heifer Development, Reproduction, Marketing

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

Reproductive management and artificial insemination (AI) are important components of any successful dairy operation. These practices require a thorough understanding of the changes in physiology and endocrinology that occur during the estrous cycle of dairy cows and heifers. This review will cover the basic physiology and endocrinology of the estrous cycle in cattle, and provide an overview of our current understanding of ovarian follicular waves. Topics to be covered that specifically address basic physiology and endocrinology of the estrous cycle will

include: 1) follicular development; 2) endocrinology associated with follicular development; 3) corpus luteum development and regression; 4) endocrinology associated with corpus luteum function; and 5) a summary of the estrous cycle. This review will also include an overview of prostaglandin $F_{2\alpha}$, GnRH, estradiol cypionate (ECP), and progestins in terms of their applications in estrus and/or ovulation synchronization protocols. A better understanding of physiology and endocrinology of the estrous cycle will improve reproductive management of dairy cattle and facilitate the successful application of AI, including fixed-time AI protocols.

**Key Words:** Estrous Cycle, Dairy Cattle

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

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

**Key Words:** CIDR, Synchronization, Embryo Transfer

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

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

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

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

**Key Words:** Reproduction, Monitoring, Pregnancy Rate

## Graduate Student Competitive Research Papers - Ph.D. Division

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

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

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

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

Two experiments were conducted to determine if including DDGS in the diet reduces the incidence and/or severity of infection in growing pigs after a L. intracellularis challenge. In Experiment 1, eighty 17-d old weaned pigs were blocked by sex and weight and randomly allotted to one of four treatment groups: negative control (NC) - unchallenged, corn-soy diet; positive control (PC) - challenged, corn-soy diet; 10% DDGS diet (10D) - challenged; and 20% DDGS diet (20D) - challenged. Challenged pigs were orally inoculated with $1.5 \times 10^9$ L. intracellularis