SYMPOSIA AND ORAL SESSIONS

Extension—Dairy

61 Distance coverage study of the self–powered sensor based smart wireless identification and tracking tag for production agriculture application. K. Dhakal*[1], T. Ma[2], M. Hempel[2], J. F. Keown[1], and H. Sharif[2], *[1]University of Nebraska, Department of Animal Science, Lincoln, [2]University of Nebraska, Department of Computer and Electronics Engineering, Lincoln.*

A prototype smart animal ear tag has been developed to meet the United States Department of Agriculture (USDA) animal disease traceability requirement. This novel smart tag is a self–powered device capable of complete animal identification and tracking. It also integrates sensors to monitor real-time health conditions of livestock. Information on animal health, breeding and vaccination records can also be locally stored and retrieved from these small, economical and securely accessible wireless tags. These smart tags are capable of self-organizing into wireless ad–hoc networks for data reporting and retrieval. This work presents our study of: 1) the effective distance coverage of a smart tag for a single hop and 2) the distance range for relaying through multiple tags (multi–hop communication). Six prototype smart tags were used in the experiment for this study. Distance was taken as a dependent variable and signal packets as an explanatory variable. The estimate of the intercept is 43.409 and the independent variable signal packets is −0.7634; giving distance = 43.409 – 0.7634*signal packets as a fitted line. The mean distance range for a single hop is measured to be 22.6 ± 1.38 m. The total distance coverage using 6 tags plus the central computer receiving station using multi–hop communication was 136 ± 1.58 m. However, due to their ad–hoc wireless nature, the true size of the network is only limited by the number of available smart tags. The more tags are connected, the larger the network will become and the larger the provided coverage area will be. With encrypted information for data privacy, wireless identification and its ability to operate purely on energy harvested from its environment such as solar power, body heat, animal motion, and ambient RF; the smart ear tag would be very beneficial in livestock production environments compared with other animal identification technologies.

Key Words: smart tag, self-powered, tracking, wireless

62 On heterogeneous associations between milk production and reproduction in dairy cows. N. M. Bello*[1], J. P. Steibel[2], R. J. Erskine[2], and R. . Tempelman[2], *[1]Kansas State University, Manhattan, [2]Michigan State University, East Lansing.*

The series of studies presented herein have as a main objective to investigate the nature of the association between milk production and reproductive performance of dairy cows taking into consideration its within-herd (cow-level) and between-herd (herd-level) components. We also evaluate management practices and herd attributes as potential sources of heterogeneity in this association. We implement recently developed bivariate hierarchical Bayesian models to explore heterogeneity in cow-level and herd-level production-reproduction associations using large data sets from commercial dairy farms in Michigan. The proposed hierarchical Bayesian models introduce a new dimension of heterogeneity to study the mutual association between production systems and individual animals, namely that of heterogeneous covariances (or correlations) between outcomes of interest. Evidence for heterogeneity in the association between milk production and reproduction was overwhelming. Most notably, inferred associations were generally quite different and, in some cases, opposite in sign between the cow-level and the herd-level components. Second, management practices and herd attributes were identified as sources of heterogeneity in the production-reproduction relationship. In particular, intensive management conditions led to a more favorable association between production and reproduction in some cases (e.g., estimated herd calving interval decreased by 1.4 ± 0.1 d per 100 kg increase in cumulative milk yield for herds using bovine somatotropin treatment) or to a partial alleviation of an overall antagonism in others (i.e., 21% greater pregnancy rates among herds implementing more frequent milking schemes). Understanding the multidimensional levels of heterogeneity in the associations between milk production and reproductive performance should have direct implications for tailoring dairy management programs that optimize overall dairy cow performance in current production systems.

Key Words: dairy cow, heterogeneous association, milk production, reproduction

63 Does size of a dairy farm affect its carbon footprint? J. Paulson*[1], T. Olson[1], and G. Thoma[2], *[1]University of Minnesota, St.Paul, [2]University of Arkansas, Fayetteville.*

A survey of 12 Minnesota dairy farms was conducted the summer of 2009. Farms ranged in size from 45 to 750 cows with a variety of housing, cropping and manure handling methods. From the data collected, kg of CO_2 equivalent/ kg of Fat and Protein corrected milk produced (FPCM) was calculated using a weighted delta-log mean distribution. Data was compared with LCA (Life Cycle Assessment) data for MN and the Region. Comparisons were made for Feed, Enteric, Manure, Fuel, and total farm footprint. Except for single outliers, there was little correlation to herd size for the calculated carbon footprint for items considered except for total farm. Data analyzed will determine needs for education among Minnesota farms.

Table 1. Weighted Delta Log Normal Statistics - all units Kg CO2e/ kg FPCM

		Fuels	Enteric	Feed	MMS	Total
Region 3	Mean	0.073	0.411	0.303	0.336	1.119
	lower 95% CI	0.070	0.404	0.297	0.309	1.092
	upper 95% CI	0.077	0.417	0.310	0.364	1.147
National	Mean	0.068	0.428	0.333	0.410	1.228
	lower 95% CI	0.064	0.423	0.327	0.386	1.204
	upper 95% CI	0.072	0.434	0.339	0.436	1.252
Minnesota	Mean	0.063	0.418	0.317	0.365	1.160
	lower 95% CI	0.057	0.407	0.305	0.317	1.107
	upper 95% CI	0.069	0.430	0.328	0.419	1.217
Twelve farms	Mean	0.075	0.397	0.275	0.327	1.072
	lower 95% CI	0.063	0.382	0.261	0.255	1.004
	upper 95% CI	0.089	0.414	0.290	0.421	1.145

Key Words: dairy, carbon footprint, sustainable

64 The effect of dietary trace minerals source and amount during the dry period on health and performance of the dam and progeny. G. L. Golombeski*[1], J. Linn[1], H. Chester-Jones[2], M. Socha[3], and M. Raeth-Knight[1], *[1]Univeristy of Minnesota, St. Paul, [2]University of Minnesota, Southern Research and Outreach Center, Waseca, [3]Zinpro Corporation, Eden Prairie, MN.*

Trace minerals (TM) such as Co, Cu, Mn, and Zn have important roles in physiological processes related to growth, reproduction, and health. Studies have confirmed that feeding amino acid complexes of trace minerals to dairy cattle pre- and postpartum may result in improved milk yield, immune function, decrease incidence of hoof health and mastitis. There is limited research evaluating the effect of trace mineral supplementation during the dry period on nutrient composition and immunoglobulin content of colostrum. Supplementation of organic zinc sources during gestation in swine and the pre-hatch period in chickens has increased development of intestinal villi and enhanced nutrient absorption in the offspring. The objectives of the current study were to investigate the effects of supplemental dietary TM source and amount during the dry period on: 1) health and performance of dairy cows at parturition and during the subsequent lactation and 2) health, and growth performance of calves during the first 56 d of life. Fifty-two Holstein and cross-bred cows at the University of Minnesota-St. Paul and 62 Holstein cows at the University of Minnesota-Northwest Research and Outreach Center were randomly assigned to 1 of 3 treatments. Treatments were source of TM and amount of Zn supplementation: CON = inorganic; OTM = 1/3 organic and 2/3 inorganic; and OTMZ = OTM with additional Zn from zinc-methionine. Treatments provided the following supplemental TM during the dry period: CON = 25, 193, 410 and 1375 mg/d of Co, Cu, Mn, and Zn respectively; OTM = 24, 205, 406, and 1337 mg/d respectively; and OTMZ = 10, 133, 336, and 3092 mg/d respectively. Under conditions of this study, TM source or Zn supplementation of the dam prepartum did not affect liver TM concentrations of the dam at parturition or subsequent lactation performance or daily gain of calves through 56 d of life ($P \geq 0.05$).

Key Words: trace minerals, dry cows, colostrum, calf performance

65 Calculating starch digestibility by lactating dairy cows from starch concentrations in feed and feces. F. N. Owens* and A. T. Hassen, *Pioneer Hi-Bred International, Johnston.*

The relationship of starch digestibility to starch concentration of feed and feces was examined by compiling starch digestion data from published research trials with lactating dairy cows. The 235 corn-based diets in the data set averaged 28.0 ± 6.1% starch (DSTA) and 92.0 ± 5.6% starch digestibility (SD). Where not presented, fecal starch concentration as a percentage of fecal organic matter (FSTA) was calculated from reported digestibility of starch and of dry matter or organic matter. As a fraction of fecal organic matter, FSTA averaged 7.2% ± 5.0% with a range from 0.6 to 25.8%. SD was not significantly correlated with dietary CP, NDF, or ADF, but SD was associated ($P < 0.05$) with diet OM, FSTA, and fecal NDF. Models were built by simple regression procedures, by ANOVA with study as a fixed effect, and by mixed model procedures with and without weighting by the standard deviation of SD. In addition, 27 data points were reserved for validation. Equations developed by different procedures had similar intercepts and slopes. Models to calculate SD were built using FSTA alone, with FSTA plus DSTA, and with these 2 factors plus FSTA x DSTA. Based on the mixed model approach without weighting, equations for these 3 model types were: SD = 99.95 – 1.1367 x FSTA with r = 0.96 and SEP = 0.47; SD = 95.29 – 1.1677 x FSTA + 0.18559 x DSTA with r = 0.99 and SEP = 0.25; and SD = 99.63 – 2.2489 x FSTA + 0.02168 x DSTA + 0.037546 x FSTA x DSTA with r = 0.99 and SEP = 0.21. Results indicate that starch digestibility by lactating cows in digestion trials could be predicted reliably from DSTA and FSTA alone. This indicates that analysis of feed and feces should prove useful to quantify SD at commercial dairies. Precision of estimates of SD from FSTA likely will be limited less by imprecision of these equations than by inability to obtain a representative sample of feces.

Key Words: starch, digestibility, feces, dairy

Extension—Dairy: Using Computerized Tools in Dairy Management

66 Exploring methods to assess the economic value of dairy cattle reproductive programs. V. E. Cabrera,* *University of Wisconsin, Madison.*

A direct relationship between reproductive performance and profitability has long been recognized, but its quantification remains a challenge. The assessment is difficult because the most important economic factors of a dairy farm business such as lactation length, culling and mortality, calving interval, and cost of reproductive programs interact dynamically with the reproduction efficiency. Therefore, the prediction of the demographics and their economics of a dairy herd under a reproductive program requires sophisticated techniques, which together with farm specific conditions, warrant the need of a suite of methodological options. This study explores the utilization of adjusted partial cash flows (APF), Markov-chain (MC) simulations, and dynamic programming (DP) optimizations to assess the value of reproductive programs. The objectives are: 1) describe the application of these techniques to reproductive economic evaluation and 2) discuss the strengths and weaknesses of these methods under practical applications. The APF uses reproductive events to estimate partial economic values, which are discounted to the present, aggregated, and adjusted to a defined unit of time. The APF allows for large detail in the definition of reproductive programs, but is limited in the inclusion of the interactions of several lactations, abortions, and replacement events. The MC simulates a herd and its replacements for long periods of time to have an economic assessment resulting from a final (constant) herd structure. The MC overcomes the APF limitations, but requires reproductive programs to be adjusted to the dimensions of the model. The DP is the most complex framework based on Markov-chain arrangements that optimizes the dairy herd structure under a defined reproductive program. A major limitation of DP is that it is less suitable for user-friendly decision support systems. Overall, these models are reporting that pure timed artificial (TAI) insemination programs outperform to those pure heat detection (HD) programs and that the combined TAI with HD could be better or worse than pure TAI programs depending on the HD performance.

Key Words: simulation, modeling, reproductive efficiency

67 Linear programming to evaluate the economics of reproductive efficiency and sexed semen considering herd constraints. A. De Vries,* *University of Florida, Gainesville.*

Linear programming is a technique for the optimization of a linear objective function, subject to linear equality and linear inequality constraints. The technique can be used to evaluate optimal replacement and insemination decisions for dairy heifers and cows considering herd constraints. A herd constraint such as a closed herd or a limiting milking parlor capacity implies that optimal insemination and replacement decisions for individual animals are not independent. Therefore, simultaneous calculation of optimal decisions for all animals in the herd is needed. A linear programming model was developed to evaluate the optimal semen mix in a closed herd considering conventional dairy semen, sexed female dairy semen, and conventional beef semen. The model considered a maximum of 10 parities including heifers. Heifers and cows were allowed at most 8 and 10 insemination opportunities per parity, respectively. Time step between insemination decisions depended on service rates. Inputs were genetic merit of calves by age and level of milk production of the dam and semen type, lactation curves, milk price, feed costs, insemination costs, conception rates, dystocia costs, involuntary culling risks, and other variable and fixed costs. Herd constraint was the requirement that enough born dairy heifer calves were raised to replace culled cows. Extra heifer calves were sold at $200, dairy bull calves at $50, and crossbred calves at $150. As a result, in heifers 49% of all inseminations were with conventional dairy semen, 41% with sexed semen, and 10% with beef semen. In first parity cows, these percentages were 53%, 30%, and 17% respectively. In later parity cows, 42% of all inseminations were with beef semen. When the crossbred calf price was increased to $300, the use of sexed semen in heifers increased to 76% of all inseminations and the use of beef semen in first parity and later parity cows increased to 45% and 71%, respectively. Including seasonality in milk production and fertility resulted in the use of beef semen in cows and sexed semen in heifers primarily during the winter and conventional semen during the summer. These illustrations show that the linear programming model formulation allows for exploring realistic optimal replacement and insemination decisions when herd constraints need to be considered.

Key Words: reproduction, sexed semen, constraint

68 Stochastic modeling of the economic and biological risks associated with Precision Dairy Farming investment decisions. J. M. Bewley,* *University of Kentucky, Lexington.*

Dairy managers must consider both biological and economic considerations simultaneously in their decisions. Traditionally, investment decisions have been made using standard recommendations, rules of thumb, consultant advice, or intuition. But, more objective methods of investment analysis are needed. Empirical comparisons of technology before or after adoption or between herds that have adopted a technology and control herds that have not adopted are expensive and biased by other, possibly herd-related differences. A dynamic, stochastic, mechanistic simulation model of a dairy enterprise was developed to evaluate the cost and benefit streams coinciding with investments in Precision Dairy Farming technologies. This approach addresses many issues that have been a hindrance to this type of analyses. For example, enumerating the risk of response to technology investment is difficult especially if the technology has no history from which to enumerate probabilities. Management must rely on expert opinion as a first-best guess of what these risks would be. The model was constructed to embody the biological and economical complexities of a dairy farm system within a partial budgeting framework. A primary objective was to establish a flexible, user-friendly, farm-specific, decision-making tool for dairy producers or their advisers and technology manufacturers. The basic deterministic model was created in Microsoft Excel (Microsoft, Seattle, WA). The @ Risk add-in (Palisade Corporation, Ithaca, NY) for Excel was employed to account for the stochastic nature of key variables within a Monte Carlo simulation. Net present value was the primary metric used to assess the economic profitability of investments. The model comprised a series of modules, which synergistically provided the necessary inputs for profitability analysis. Estimates of biological relationships within the model were obtained from the literature in an attempt to represent an average or typical US dairy. Technology benefits were appraised from the resulting impact on disease incidence, disease impact, and reproductive performance. The economic feasibility of investment in an automated BCS system and an automated temperature monitoring system were explored to demonstrate the utility of this model.

Key Words: stochastic modeling, investment analysis, Precision Dairy Farming

69 Modeling and implementing feed management decisions into whole farm nutrient management. J. Harrison*[1] and A. Rotz[2], *[1]Washington State University, Puyallup, [2]USDA / Agricultural Research Service, State College, PA.*

Feed management plays a major role in whole farm nutrient management. On most dairy farms, imported feed contributes more than 50% of the nutrients entering the farm. Export of nutrients from the farm in milk approximates 30% or less of the nitrogen and phosphorus consumed by the herd. Whole farm nutrient management must consider the magnitude and role that feed management decisions have on whole farm nutrient flows. Software tools are helpful when quantifying and evaluating feed management options. Three tools will be used to demonstrate the scope that feed management plays in whole farm nutrient management. The tools are: Whole Farm Balance Nutrient Education Tool (WFBNET) and Feed Nutrient Management Planning Economics (FNMP$) (http://www.puyallup.wsu.edu/dairy/nutrient-management/software.asp); and the Integrated Farm System Model (IFSM - http://www.ars.usda.gov/Main/docs.htm?docid = 8519). WFBNET was developed to quickly aid dairy producers with understanding nutrient management at the whole farm level. (FNMP$) was developed to connect feeding decisions to the whole farm level and to estimate environmental and implication of feed management decisions. IFSM was developed to evaluate the impact of a wide range of management decisions such as cropping strategy, feeding options, manure handling methods, equipment selection, and weather factors on environmental and economic performance of farms. Factors such as forage selection and use of high phosphorus byproduct feeds will be used to show the impact that these decisions have on economics and environmental factors.

Key Words: dairy, feed Management, whole farm nutrient management

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SYMPOSIA AND ORAL SESSIONS

Extension—Dairy: Controlling Infectious Claw Lesions with Footbaths and Potential Environmental Implications

70 Hoofbaths and topical treatments to prevent and control digital dermatitis in cattle. Does best practice management of the hoofbath and prompt detection and treatment achieve clinical, histopathological and microbiological cure? A. Gomez,* A. F. Dusick, D. Döpfer, and N. B. Cook, *University of Wisconsin, Food Animal Production Medicine, Madison.*

Hoofbaths and topical treatments represent the most common strategies in DD prevention and control. Despite their widespread use, inconsistent results in decreasing DD prevalence have been reported, and many questions arise about their effectiveness. The complex DD etiology, inaccurate assessment of the disease, lack of standard methods for evaluating interventions aiming to control DD, and poor compliance with the control programs are the main reasons for the observed unsatisfactory results. Our research group has been focused on developing and identifying appropriate methods and management practices that will lead to an optimal use of the existing tools to control DD. In addition, innovative lines of research are being explored to enhance our knowledge of the disease and find possible new intervention strategies. To address the problems we currently face in the field, we will discuss the results from the following recent studies: 1. A hoofbath design trial to determine optimal dimensions to maximize foot steps per bath and minimize the volume of the chemical used; 2. A hoof bath field trial used to determine the clinical effectiveness of a novel hoofbath chemical, stressing the importance of long-term evaluation of products and the handling of individual cow susceptibility profiles in the analysis; 3. A bench-top assay to evaluate the minimum bactericidal concentration of chemicals for the control of Treponema spp, and 4. Clinical, histopathological and microbiological DD cure assessment from clinical cases sampled before and after topical treatment.

71 Copper accumulation in dairy forage production systems. T. Downing, K. Stiglbauer, M. Gamroth,* and J. Hart, *Oregon State University, Corvallis.*

Dairy farmers often use either CuSO4 or ZnSO4 solutions in footbaths to control diseases of the hoof. Solutions are frequently changed before each milking requiring significant quantities of Cu and/or Zn a year. Used solutions are dumped into the dairy manure handling system and applied to fields in their liquid manure system. The objectives for this project were to survey 30 dairy farms in Oregon to estimate the amount of CuSO4 and ZnSO4 used in footbaths, measure mineral concentrations in soils on the farm, access the concentration of Cu and Zn in the manure system and measure minerals in the forage produced on the dairy. Footbath practices were recorded for each dairy. Soils samples were collected from 2 major fields at 6â€ deep and analyzed for Cu and Zn. Forages grown on the farm were sampled and analyzed for Cu and Zn and manure was collected directly from milk cows and from the liquid manure storage system. Forages, soils and manure were all analyzed at Agri-Check Labs, Umatilla, OR. Footbath usage by farm ranged from no usage to continuous usage. Soil Cu concentrations ranged from 0.7 to 34.7 ppm and averaged 5.7 + 6.6. Soil Zn concentrations ranged from 0.6 to 41.8 ppm averaging 10.1 + 9.3. Forage copper concentrations ranged from 1 to 10 ppm averaging 3.4 + 2.1 and Zn ranged from 3 to 51 ppm averaging 13.8 + 10.3. Fresh manure Cu concentrations directly from milking cows were very consistent, typically at 10 ppm, with Cu concentrations in the manure storage ranging from 2 to 58 ppm averaging 10.3 + 12.02 ppm. The use of CuSO4 and ZnSO4 in footbaths on dairies in Oregon continues to be a common practice. Over 75% of dairy soils tested are considered high (>2ppm) in Cu concentration and 38%were extremely high (>5ppm). Using CuSO4 and ZnSO4 in footbaths is creating potential long-term environmental and cropping challenges on many Oregon dairies.

72 Impact of high soil copper and zinc concentrations on crop production. J. Ippolito,* *USDA-Agricultural Research Service, Kimberly, ID.*

Hoof care is an important aspect of animal management. Copper or zinc sulfate (CuSO4 or ZnSO4) solutions are routinely utilized as a hoof bath regimen to prevent hoof diseases. When finished, the spent hoof bath solution is frequently disposed into lagoons with lagoon effluent later sprayed onto fields as a fertilizer source. Unfortunately, repeated application of Cu- or Zn-enriched lagoon effluent can result in topsoil metal accumulation. Because Cu and Zn are plant micronutrients, concern has arisen if this practice will result in a soil and subsequently a plant nutrient imbalance, thus leading to a decline in crop production. The role Cu and Zn play in higher plant nutrient, the potential for plant toxicity symptoms, and possible ways to mitigate future soil metal issues will be addressed.