APPENDIX D
SAES-422
Format for Multistate Research Activity
Accomplishments Report

Note: *This report is submitted each year of an activity's duration and is due 60 calendar days following the annual meeting. The SAES-422 is submitted electronically by AAs into NIMSS. Annual Reports for MRF projects are available to CRIS and CSREES through NIMSS.*

Project/Activity Number: NC2042

Project/Activity Title:

Period Covered:

Date of This Report:

Annual Meeting Date(s):

Participants: Marcia Endres

Accomplishments:

Short-term Outcomes: Use of automated technologies to milk, feed, or monitor cattle behavior are becoming more common in the USA. University of Minnesota research has helped improve the use of automated milking and feeding sytems, leading to improved cattle productivity and wellbeing. Other projects investigating feeding, resting and social behavior of prepartum cows showed that monitoring of these behaviors can help improve postpartum cow health. Investigation of large dairy facilities indicated that cattle wellbeing is adequate and economies of scale help reduce cost of producing each pound of milk.

Outputs: University of Minnesota research results were presented at JAM meetings in Orlando, ISAE International meeting in Japan, various conferences in the US and Canada, two national webinars, and were also used for teaching of undergraduate students. University of Minnesota and University of Kentucky organized the 2nd Precision Dairy Farming Conference and Expo in Rochester, MN where many precision dairy technologies were discussed and both institutions presented research results related to this topic.

Publications:

Liboreiro, D. N., K. S. Machado, P. Basso Silva, A. E. Barreto, M. I. Endres, and R. C. Chebel. Characterization of peripartum rumination and activity of cows diagnosed with metabolic and uterine diseases. J. Dairy Sci. 98:6812-6827.

Shahid, M.Q., J. K. Reneau, H. Chester-Jones, R. C. Chebel and M. I. Endres. 2015. Cow and herd level risk factors for on-farm mortality in Midwest US dairy herds. J. Dairy Sci. 98:4401-4414.

Lobeck-Luchterhand, K.M., P.R.B. Silva, R.C. Chebel, M.I. Endres. 2015. Effect of stocking density on social, feeding, and lying behavior of prepartum dairy animals. J. Dairy Sci. 98:240-249.

Endres, M.I. and J.A. Salfer. 2015. An evaluation of automated milking systems in the

Midwest United States. J. Dairy Sci. Vol. 98, Suppl 2:114.

Chebel, R.C., P. R. B. Silva, K. Luchterhand and M. I. Endres. 2015. Social stressors and their effects on immunity and health of periparturient dairy cows. J. Dairy Sci. Vol. 98, Suppl 2:277.

Lobeck-Luchterhand, K.M., P.R. B. Silva, R.C. Chebel, and M. I. Endres. 2015. Association between social ranking and health of transition dairy cows. J. Dairy Sci. Vol. 98, Suppl 2:565.

Lobão da Silva, D. N., Z. Sawall, J. Guillen, E. Galbraith, T. Parrott, M. Endres, and N. B. Litherland . 2015. Effect of Bacillus pumilus on performance of primiparous dairy cows fed low or high starch diets. J. Dairy Sci. Vol. 98, Suppl 2:756.

Lobão da Silva, D. N., R. Riewer, A. Gander, N. Walker, B. Ellison, M. Endres, and N. B. Litherland. 2015. Effect of Econase on rumen fermentation patterns, diet digestibility and performance pre-and postpartum of primiparous dairy cows. J. Dairy Sci. Vol. 98, Suppl 2:771.

Jorgensen, M., A.Adams Progar, K. Janni, H.Chester-Jones, J. Salfer, and M.Endres. 2015. Housing and management practices on farms using automated calf feeders in the Midwestern United States. J. Dairy Sci. Vol. 98, Suppl 2:818.

Sjostrom. L.S., B.J. Heins, M.I. Endres, R. D. Moon, and U.S. Sorge. 2015. Evaluation of winter housing systems for effects on production, udder health, BCS, hygiene, frostbite, and rumination of organic dairy cows. J. Dairy Sci. Vol. 98, Suppl 2:818.

Jorgensen, M., A.Adams Progar, S.Godden, H.Chester-Jones, A. M. de Passillé, J.Rushen, and M.Endres. 2015. Risk factors for abnormal calf health scores on farms using automated feeders in the Midwest USA. J. Dairy Sci. Vol. 98, Suppl 2:819.

Lobão da Silva, D. N., Z. Sawall, K. Froehlich, E. Galbraith, T. Parrott, M. Endres, and N. B. Litherland. 2015. Effect of Bacillus pumilus on early lactation performance of dairy cows fed low or high starch diets postpartum. J. Dairy Sci. Vol. 98, Suppl 2:821.

NC 2042: 2014 - 2015 Station Report

A. PROJECT NAME: Management Systems to Improve the Economic and Environmental Sustainability of Dairy Enterprises (Rev. NC-1119)

B. COOPERATING AGENCY and personnel: *UNIVERSITY OF WISCONSIN, Dairy Science,* ***Victor E. Cabrera***

C. WORK PROGRESS AND PRINCIPAL ACCOMPLISHMENTS and

D. USEFULNESS OF FINDINGS:

A comparison analysis of two alternative dairy cattle replacement strategies: Optimization versus Simulation models.

Kalantari, A.S., Cabrera, V.E., Solis, D.

The objective of this study was to compare the optimal replacement decisions using two alternative state-of-the-art models: the optimization dynamic programming model and the Markov chain simulation model. Lactation, month in milk and pregnancy status were used to describe cow states in a herd in both models. Both models were fed with the same parameters and transition probabilities to make the fairest comparison possible. The cow value calculated by the Markov chain model was compared against the retention pay-off estimated by the dynamic programming model. These values were used to rank all the animals in the herd. Then, the rank correlation (Spearman's correlation) was calculated between results of both models. The overall correlation was 95%, which showed a strong linear relationship between rankings of animals from the two models. Moreover, the lowest 10% ranking cows -which are the most likely replacement candidates- displayed a greater correlation, 98%. Thus, the final replacement decisions with both models were similar. A post optimality analysis was used to explore the effect of the optimal replacement decisions on the herd dynamics and herd net return. The results showed a comparable herd structure by both models. A net return was improved US$6/cow per year by using replacement decisions of both dynamic programming model and the Markov chain cow value model.

Constraints for nutritional grouping in Wisconsin and Michigan dairy farms.

Contreras-Govea, F. E., V. E. Cabrera, L. E. Armentano, R. D. Shaver, P. M. Crump, D. K. Beede, and M. J. VandeHaar.

A survey was conducted in Wisconsin (WI) and Michigan (MI) to quantify the proportion of farms that use a single diet for all lactating cows and to better understand the reasons for current grouping strategies and the limitations to grouping for better nutritional management. A questionnaire was mailed to all WI dairy farmers with ≥200 lactating cows (971 farms) and to a

random sample of grade-A MI dairy farmers (800 farms) of varying herd sizes. The survey return rate was 20% in WI (196 farms) and 26% in MI (211 farms; 59 of them had ≥200 lactating cows). Feeding 2 or more different diets to lactating cows was pre-dominant: 63% in WI (124 farms, all ≥200 lactating cows), 76% in MI farms with ≥200 lactating cows (45 farms), and 28% in MI farms with <200 lactating cows (43 farms). Farmers feeding more than 1 diet used 1 or more of the following criteria for grouping lactating cows: stage of lactation, milk production, or body con-dition score. Overall for both states, 52% of the farms (211 from 407 farms) feeding more than 1 diet grouped cows according to their nutritional needs. However, a notable population of farms fed the same diet to all lactating cows: 37% in WI (72 farms), 24% in MI (14 farms) for herds of ≥200 lactating cows, and 72% in MI for herds of <200 lactating cows (109 MI farms). “Desire to keep it simple” and “milk drops when cows are moved to a different group” were identified as main constraints to having more groups within a farm for nutritional purposes. Farm facilities and labor were also limiting factors to grouping in farms with herd sizes of <200 lactating cows.

Stochastic economic evaluation of dairy farm reproductive performance.

Kalantari, A. S., V. E. Cabrera.

The objective of this study was to assess the economic value of reproductive performance in dairy farms under uncertain and variable conditions. Consequently, the study developed methods to introduce stochasticity into transition probabilities of a Markov chain model. A robust Markov chain model with 21-d stage length and three state variables, parity, days in milk, and days in pregnancy, was developed. Uncertainty was added to all transition probabilities, milk production level, and reproductive costs. The model was run for 10 000 replications after introducing each random variable. The expected net return (US$ cow□1 yr□19standard deviation) was $3192975.0 for the baseline scenario that had 15% 21-d pregnancy rate (21-d PR). After verifying the model’s behavior, it was run for 2000 replications to study the effect of changing 21-d PR from 10 to 30% with one-unit-percentage interval. The economic gain of changing 21-d PR from 10 to 30% resulted in a US$75 cow□1 yr□1, and this overall increase in the net return was observed mainly due to the lower reproductive and culling cost and higher calf value. The gain was even greater when milk price and milk cut-off threshold decreased.

Optimizing productivity, herd structure, environmental performance, and profitability of dairy cattle herds.

Liang, D., and V. E. Cabrera.

This study used the Integrated Farm System Model to simulate the whole farm performance of a representative Wisconsin dairy farm and predict its economic and environmental outputs based on 25 yr of daily local weather data (1986 to 2010). The studied farm, located in southern Wisconsin, had 100 milking cows and 100 ha of cropland with no replacement heifers kept on the farm.

Sensitivity analyses were conducted to test the effect of management strategies on energy-corrected milk production (ECM; 4.0% fat and 3.5% protein), net return to management, and greenhouse gas (GHG; including biogenic CO2) emission. The management strategies included (1) target milk production, for which the model optimized available resources to attain, and (2) herd structure, represented by the percentage of first-lactation cows. Weather conditions affected the outputs by changing the farm quantity and the quality of produced feed resources. As expected, when target milk production increased, the ECM increased positively and linearly to a certain level, and then it in-creased nonlinearly at a decreasing rate, constrained by available feed nutrients. Thereafter, the ECM reached the maximum potential milk production and remained flat regardless of higher target milk production input. Greenhouse gas emissions decreased between 3.4 and 7.3% at different first-lactation cow percentages. As the first-lactation cow percent increased from 15 to 45% in 5% intervals, GHG increased between 9.4 and 11.3% at different levels of target milk production. A high percentage of first-lactation cows reduced the maximum potential milk production. Net return to management had a similar changing trend as ECM. As the target milk production increased from 9,979 to 11,793 kg, the net return to management increased between 31 and 46% at different first-lactation cow percentages. Results revealed a win-win situation when increasing milk production or improving herd structure, which concurrently increased farm net return to management and decreased GHG emissions.

Optimization of reproductive management programs using lift chart analysis and cost sensitive evaluation of classification errors

Shahinfar, S., J. N. Guenther, D. Page, A. Samia-Kalantari, V. E. Cabrera. P. M. Fricke, and K. A. Weigel.

The common practice on most commercial dairy farms is to inseminate all cows that are eligible for breeding, while ignoring (or absorbing) the costs associated with semen and labor directed toward low-fertility cows that are unlikely to conceive. Modern analytical methods, such as machine learning algorithms, can be applied to cow-specific explanatory variables for the purpose of computing probabilities of success or failure associated with upcoming insemination events. Lift chart analysis can identify subsets of high fertility cows that are likely to conceive and are therefore appropriate targets for insemination (e.g., with conventional artificial insemination semen or expensive sex-enhanced semen), as well as subsets of low-fertility cows that are unlikely to conceive and should therefore be passed over at that point in time. Although such a strategy might be economically viable, the management, environmental, and financial conditions on one farm might differ widely from conditions on the next, and hence the reproductive management recommendations de-rived from such a tool may be suboptimal for specific farms. When coupled with cost-sensitive evaluation of misclassified and correctly classified insemination events, the strategy can be a potentially powerful tool for optimizing the reproductive management of individual farms. In the present study, lift chart analysis and cost-sensitive evaluation were applied to a data set consisting of 54,806 insemination events of primiparous Holstein cows on 26

Wisconsin farms, as well as a data set with 17,197 insemination events of primiparous Holstein cows on 3 Wisconsin farms, where the latter had more detailed information regarding health events of individual cows. In the first data set, the gains in profit associated with limiting inseminations to subsets of 79 to 97% of the most fertile eligible cows ranged from $0.44 to $2.18 per eligible cow in a monthly breeding period, depending on days in milk at breeding and milk yield relative to contemporaries. In the second data set, the strategy of inseminating only a subset consisting of 59% of the most fertile cows conferred a gain in profit of $5.21 per eligible cow in a monthly breeding period. These results suggest that, when used with a powerful classification algorithm, lift chart analysis and cost-sensitive evaluation of correctly classified and misclassified insemination events can enhance the performance and profitability of reproductive management programs on commercial dairy farms.

From cold to hot: Climatic effects and productivity in Wisconsin dairy farms.

Qi, L., B. E. Bravo-Ureta, and V. E. Cabrera.

This study examines the effects of climatic conditions on dairy farm productivity using panel data for the state of Wisconsin along with alternative stochastic frontier models. A noteworthy feature of this analysis is that Wisconsin is a major dairy producing area where winters are typically very cold and snowy, and summers hot and humid. Thus, it is an ideal geographical region for examining the effects of a range of climatic factors on dairy production. We identify the effects of temperature and precipitation, both jointly and separately, on milk output. The analysis shows that increasing temperature in summer or in autumn is harmful for dairy production, while warmer winters and warmer springs are beneficial. In contrast, more precipitation has a consistent adverse effect on dairy productivity. Overall, the analysis shows that over the past 17 years, climate change has had a negative impact on the dairy farms in Wisconsin. Alternative scenarios predict that climate change would lead to a 5% to 11% reduction in dairy production per year between years 2020 and 2039 after controlling for other factors.

Economics of production efficiency: Nutritional grouping.

Cabrera, V. E., and A. S. Kalantari.

Nutritional grouping of lactating cows under TMR feeding systems has been discussed in the literature since 1970. Most studies have concluded that using multiple, more-homogeneous TMR feeding groups is economically beneficial because of either one or both of the following outcomes: nutrient cost savings or improved productivity. Nonetheless, there has not been a consensus around or a wide adoption of this technique. By using optimal criteria for grouping and more precise nutrient specifications of diets, latest studies have reported a consistently greater income over feed cost ($/cow per yr), with multiple-TMR groups compared to 1-TMR (3-TMR = $46 and 2-TMR = $21 to $39). Critical factors that determine the economic value of nutritional grouping are:

(1) criteria for grouping, (2) nutrient specifications of diets, (3) effects on milk production, (4) health and environmental benefits, (5) number, size, and frequency of grouping; and (6) additional costs and benefits. It has been documented that grouping cows according to their simultaneous nutritional requirements (a.k.a., cluster grouping) is optimal. Cluster grouping is superior to other methods such as grouping according to days in milk, milk production, or production and body weight combined. However, the dairy industry still uses less than optimal grouping criteria. Using cluster grouping will enhance the positive economic impacts of multiple-TMR. In addition, nutrient specifications of diets for groups do not seem optimal either. Milk lead factors, which are only based on group average milk production, are used. Diets could, however, be formulated more precisely based on overall group nutrient requirements. Providing more precise diets should also be in favor of grouping economics. Furthermore, an area that requires more attention is the potential negative effect of grouping on the milk production of moved cows because of either or both social interactions or diet concentration changes. Although the literature is inconclusive on this subject matter, the latest studies indicate that multiple-TMR groups economically outperform 1-TMR even after considering plausible potential milk losses when grouping. Moreover, additional positive effects of nutritional grouping of improved herd health and environmental stewardship should be translated into economic benefits. Finally, additional costs of management, labor, facilities, and equipment required for grouping are farm specific. The few studies that have integrated these factors in their analyses found that multiple-TMR groups would still be economically superior to 1-TMR.

Economic impact of nutritional grouping in dairy herds

Kalantari A. S., L. E. Armentano, R. D. Shaver, and V. E. Cabrera.

This manuscript evaluates the estimated economic impact of nutritional grouping in commercial dairy herds using a stochastic Monte Carlo simulation model. The model was initialized by separate datasets obtained from 5 commercial dairy herds. These herds were selected to explore the effect of herd size, structure, and characteristics on the economics and efficiency of nutrient usage according to nutritional grouping strategies. Simulated status of each cow was updated on a daily basis together with the nutrient requirements of net energy for lactation (NE_L) and metabolizable protein (MP). The amount of energy consumed directly affected BW and BCS changes. Moreover, to control the range of observed BCS in the model constraints on lower (2.0) and upper (4.5) bounds of BCS were set. Each month, the clustering method was used to homogeneously regroup the cows according to their nutrient concentration requirements. The average NE_L concentration of the group and a level of MP (average MP, average MP+0.5xSD, or average MP+1xSD) were considered to formulate the group diet. The calculated income over feed costs gain (IOFC, $/cow per yr) of having more than 1 nutritional group among the herds ranged from $33 to $58, with an average of $39 for 2 groups and $46 for 3 groups, when group was fed at average NE_L concentration and average MP+1xSD concentration. The improved IOFC was explained by increased milk sales and lower feed costs. Higher milk sales were a result of fewer

cows having a milk loss associated with low BCS in multi-group scenarios. Lower feed costs in multi-group scenarios were mainly due to less RUP consumption. The percentage of total NE_L consumed captured in milk for greater than 1 nutritional group was slightly lower than 1 nutritional group due to better distribution of energy throughout the lactation and higher energy retained in body tissue, which resulted in better herd BCS distribution. The percentage of N fed captured in milk increased with more than 1 group, and was the most important factor for improved economic efficiency of the grouping strategies.

E. PUBLICATIONS:

Peer-reviewed research and extension Journal papers

1 Kalantari A. S., L. E. Armentano, R. D. Shaver, and **V. E. Cabrera**. Accepted 19 October 2015. Economic impact of nutritional grouping in dairy herds. Journal of Dairy Science 00:00-00.

2 **Cabrera, V. E.**, and A. S. Kalantari. Accepted 13 September 2015. Economics of production efficiency: Nutritional grouping. Journal of Dairy Science 00:00-00.

3 Qi, L., B. E. Bravo-Ureta, and **V. E. Cabrera**. Accepted 28 August 2015. From cold to hot: Climatic effects and productivity in Wisconsin dairy farms. Journal of Dairy Science 00:00-00.

4 Shahinfar, S., J. N. Guenther, D. Page, A. Samia-Kalantari, **V. E. Cabrera.** P. M. Fricke, and K. A. Weigel. 2015. Optimization of reproductive management programs using lift chart analysis and cost sensitive evaluation of classification errors. Journal of Dairy Science 00:00-00.

5 Liang, D., and **V. E. Cabrera**. 2015. Optimizing productivity, herd structure, environmental performance, and profitability of dairy cattle herds. Journal of Dairy Science98:2812-2823.

6 Kalantari, A. S., **V. E. Cabrera**. In press. Stochastic economic evaluation of dairy farm reproductive performance. Canadian Journal of Animal Science 00:00-00.

7 Contreras-Govea, F. E., **V. E. Cabrera**, L. E. Armentano, R. D. Shaver, P. M. Crump, D. K. Beede, and M. J. VandeHaar. 2015. Constraints for nutritional grouping in Wisconsin and Michigan dairy farms. Journal of Dairy Science 98:1336-1344.

8 Kalantari, A. S., **V. E. Cabrera**, D. Solis. 2015. A comparison analysis of two alternative dairy cattle replacement strategies: Optimization versus simulation models. Revista Economía Agraria ISSN 0718-9141. 18:12-24.

Contributed papers or abstracts research and extension

1 **Cabrera, V. E.** 2015. Economics of production efficiency: Nutritional grouping. Journal of Dairy Science 98 (Suppl. 2): 350.

2 Liang, D., T. F. Rutherford, and **V. E. Cabrera**. 2015. Optimal dairy farm management subject to greenhouse gas emissions constraints. Journal of Dairy Science 98 (Suppl. 2): 406.

3 Kalantari, A. S., L. E. Armentano, R. D. Shaver, and **V. E. Cabrera**. 2015. Economic impact of nutritional grouping in dairy herds. Journal of Dairy Science 98 (Suppl. 2): M279.

4 Weigel, K. A., A. A. Mikshowsky, and **V. E. Cabrera**. 2015. Effective use of genomics in sire selection and replacement heifer management. Western Dairy Management Conference. Reno, Nevada. 3-5 March 2015.

F. IMPACT STATEMENT (in lay language for government agencies and elected representatives)

Management information systems are increasingly important for helping in the decision-making of dairy systems. Indeed, dairy farming is a decision-intensive enterprise where profitable decisions cannot be made without the use of decision aids. The dynamics of dairy farm systems warrants the utilization of sophisticated techniques to assess the impacts of management strategies to farm economics, which at the same time need to be user-friendly and ready to be applied at the farm level. Simulation techniques help to overcome these shortcomings assessing cost-efficiency and profitability even under highly uncertain scenarios. Wisconsin's applied research and extension programs are committed to provide relevant, up-to-date, research based, and field-tested decision aids to farmers, extension agents.

G. LEVERAGE (*dollars and other resources – because of your work in this project you've been able to leverage resources from what other sources, amounts?***):**

Cabrera, V.E., and R. D. Shaver. 2015-2019. Nutritional grouping strategies for feeding dairy cattle to improve health, profit, and environmental outcomes of dairy farms. USDA Hatch Multistate Interdisciplinary. $140,000.

Cabrera, V.E. 2013-2017. Improving long-term dairy farm sustainability applying whole-farm best management practices that enhance profitability and decrease environmental impacts: A high-level integrated assessment. USDA Hatch Multistate Single Investigator. $165,000.

Bravo-Ureta, B. (PD), A. De Vries, A., R. Mosheim, and **V. E. Cabrera**. 2012-2016. Interaction between productivity growth and environmental factors for multi-output farms with a dairy focus. USDA National Institute of Food and Agriculture, Agriculture and Food Research Initiative Competitive Grant Programs: Agriculture Economics and Rural Communities. $318,000.

VandeHaar, M. (PD), K. A. Weigel, L. E. Armentano (WI-PD), D. Moody Spurlock, R. Tempelman, R. Veerkamp, **V. E. Cabrera**, M. Worku, M. Hanigan, C. Staples, D. Beede, R. D. Shaver, M. A. Wattiaux, J. Dijkstra, R. Pursley, and M. Weber Nielsen. 2011-2016. Genomic selection and herd management tools to improve feed efficiency of the dairy industry. USDA National Institute of Food and Agriculture, Agriculture and Food Research Initiative Competitive Grants Program: Improving Sustainability by Improving Feed Efficiency of Animals. $5,000,000.

Annual Project Report
North Central Cooperative Research Project NC-2042
Year ending September 30, 2015

A. Project Management Systems to Improve Economic and Environmental Sustainability of Dairy Enterprises

B. Cooperating Agency: South Dakota State University, Brookings, SD 57007

Personnel: J.L. Anderson, Assistant Professor
Dairy Science Department

Project Objectives
Main objective: To evaluate and develop sustainable management systems for dairy herds that address critical quality and variance control factors with implications to economic efficiencies and environmental impacts.

1) To analyze management and nutrition strategies for replacement heifers as they pertain to production and profitability (heifers)
2) To optimize lactating and dry cow decision-making as it relates to animal health, nutrient utilization, milk production, reproduction, and profitability (cows)
3) To evaluate system components and integration of information into decision-support tools and whole farm analyses to improve efficiency, control variation, and enhance profitability, and environmental sustainability (whole farm)

C. Work progress and principal accomplishments:

Objective 1: To analyze management and nutrition strategies for replacement heifers as they pertain to production and profitability (heifers).

1. Growth performance, nutrient utilization, metabolic profile, and onset of puberty in dairy heifers fed reduced fat distillers grains in replacement of forage in limit-fed rations.

This study evaluated feeding reduced-fat distillers dried grains with solubles (RFDDGS) in replacement of forage to dairy heifers. A 16-wk randomized complete block design study was conducted using 48 Holstein heifers (199 ± 1.92 d of age; initial body weight (BW) of 266±4.98 kg). Treatments diets were: 1) 30% RFDDGS with 68.5% grass hay (**30DG**); 2) 40% RFDDGS with 58.5% grass hay (**40DG**) and 3) 50% RFDDGS with 48.5% grass hay (**50DG**) on a DM basis. All diets also contained 1.5% mineral mix. Rations were limit-fed so that the amount of feed offered as a percentage of body weight (BW) decreased across treatments as the dietary percentage of RFDDGS increased. Rations were offered at 2.65, 2.50, and 2.35% of BW on a DM basis for 30DG, 40DG and 50DG, respectively. This allowed for similar intakes of crude protein and energy across treatments. Frame sizes, BW and body condition scores were measured on two consecutive days during wk 0, 2, 4, 6, 8, 12, 14, and 16 of the feeding period. Jugular blood samples were collected on two days during wk 0, 4, 8, 12, and 16 for metabolite and metabolic hormone analysis. When heifers weighed 200 kg, coccygeal vein blood samples were taken twice per wk for

progesterone analysis to estimate onset of puberty. Data were analyzed in SAS 9.4 using repeated measures in MIXED procedures. Orthogonal contrasts were used for determination of linear and quadratic effects.

Results demonstrated that heifer dry matter intake (DMI) linearly decreased ($P<0.01$) with increasing concentrations of RFDDGS in the diet (6.49, 6.21, and 5.84 kg/d for 30DG, 40DG, and 50DG, respectively). Body weights (264.1, 266.2, and 266.4 kg) and average daily gain (0.89, 0.94, and 0.97 kg/d) were similar ($P>0.10$) among treatments. Gain to feed (0.14, 0.16, and 0.18 kg) linearly increased ($P<0.01$) with increasing concentrations of dietary RFDDGS. Hip height (124.8, 124.7, and 124.8 cm) and hip width (35.6, 35.8, and 35.8 cm) were similar among treatments ($P>0.10$). There was a tendency ($P= 0.06$) for a linear increase in body length (112.5, 112.9, and 113.1 cm) as dietary concentrations of RFDDGS increased. There was a quadratic effect ($P<0.05$) for wither height (120.9, 121.7, and 121.6 cm), paunch girth (172.5, 173.9, and 172.5 cm), and body condition score (3.11, 3.12, and 3.07), and a quadratic tendency for heart girth (140.9, 140.6, and 140.9 cm). Serum glucose (76.3, 77.7, and 77.3 mg/dL) and plasma leptin (4.42, 4.35, 4.59 ng/mL) were similar ($P > 0.05$) among treatments. There were quadratic effects ($P < 0.05$) for plasma cholesterol (93.5, 89.2, and 97.1 mg/dL), plasma urea nitrogen (17.8, 17.8, and 19.9 mg/dL), and a quadratic tendency ($P = 0.05$) for IGF-1 (102.7, 100.0, and 109.4 ng/mL). Age at puberty (234.6, 244.3, and 235.5 d) and BW at puberty (246.4, 261.3, and 254.0 kg; SEM=24.9) were similar ($P > 0.10$) among treatments. However there was a significant treatment ($P <0.01$) treatment by age interaction for age at puberty, with a larger percentage of heifers on 50DG beginning to cycle at earlier ages compared to the other treatments.

Overall results demonstrate that heifers can be limit-fed diets with greater inclusion rates of RFDDGS than previously recommended and maintain growth performance and energy status, without accumulating excess adipose tissue as indicated by leptin. Feed efficiency is improved by including more RFDDGS heifer diets in replacement of forage in limit-fed rations. Treatments had no detrimental effects on age or BW at puberty; however at this time data is still being collected on post-trial reproductive and lactation performance.

2. Evaluation of the potential of camelina meal as a feedstuff for growing dairy heifers.

The objective of this research trial was to evaluate the growth performance, metabolic profile, and nutrient utilization of dairy heifers fed camelina meal (CAM) compared to distillers dried grains with solubles (DDGS) or linseed meal (LIN) or. A 12-wk randomized complete block design study was conducted using 33 Holstein and 9 Brown Swiss heifers (144.8 ± 22 d of age; body weight (BW) 171.8 ± 24.3 kg) with three treatments. Treatments were 10% of the diet as CAM, LIN, or DDGS (DM basis). All diets contained 60% grass hay and 40% concentrate mix. In addition to the test feeds, concentrate mixes included corn and soybean meal, at slightly different inclusion rates to make diets isocaloric and isonitrogenous. Treatment diets were formulated to contain 14.5% CP and provide a NEg of 0.8 Mcal/kg. Diets were limit-fed to 2.65% of BW using a Calan gate feeding system. Frame sizes, BW, and body condition scores (BCS) were measured on two days during wk 0, 2, 4, 6, 8, 10, and 12. Two days during wk 0, 4, 8, 12 jugular blood was collected 4 h post-feeding for evaluation of metabolic profile. During week 8 and 12 rumen fluid was also collected via esophageal tubing. Data were analyzed in SAS 9.4 using repeated measures in MIXED procedures. Tukey's test was used for mean comparisons.

Results showed that heifer dry matter intake was similar between CAM and LIN, but greater (*P = 0.03*) for DDGS (4.83, 4.82, and 5.03 kg/d; for CAM, LIN, and DDGS, respectively). Body weights (BW) (199.5, 210.9, and 205.1 kg) were found to be less (*P < 0.01*) for heifers fed CAM and greatest for LIN. Average daily gain (ADG) (0.65, 0.72, 0.80 kg/d) CAM tended (*P= 0.10*) to less than LIN. Gain to feed (0.14, 0.17, 0.15 kg/d) was similar for CAM and DDGS, but greater (*P < 0.05*) for LIN. Most frame measurements were similar among treatments. Hip width (31.7, 31.3, and 31.4 cm) had a tendency (*P=0.06*) to be greater in the CAM treatment. Body length (105.2, 102.0, and 103.3 cm) was found to be greater (*P < 0.05*) for CAM compared to LIN and DDGS. Body condition score (3.16, 3.10, and 3.17) was greater (*P < 0.01*) for CAM and DDGS compared to LIN. The rumen total VFA, acetate: propionate, and pH were similar among treatments (*P > 0.05*). Acetate (67.6, 67.1, and 66.7 mM/100mM) was found to be greater for CAM, LIN had a similar acetate proportion and DDGS had the least. Propionate and iso-butyrate were also greater compared to DDGS but similar to LIN. However these differences are numerically small and should not alter rumen function. Butyrate (9.4, 9.9, 11.0 mM/100mM) was less in the CAM treatment compared to LIN and DDGS. Rumen ammonia (12.2, 7.4 and 10.7 mg/dl) was less (*P<0.05*) in heifers fed DDGS compare to LIN or CAM. For blood metabolites, serum glucose (78.3, 79.6, and 77.1 mg/dl) and plasma triglycerides (15.8, 16.3 and16.0 mg/dl) were similar (*P>0.10*) among treatments. Cholesterol (71.6, 70.0 and 65.6 mg/dl) tended (*P=0.10*) to be greater in CAM compare to LIN. Plasma urea nitrogen (10.8, 11.6 and 13.0 mg/dl) was greater (*P<0.05*) in heifers fed LIN. The metabolic hormone IGF-1(85.9, 91.7,92.7 ng/ml) was statistically similar among treatments, however it was noted that IGF-1 was numerically less in CAM fed heifers which may partially explain lesser ADG. Thyroid hormone thyroxine (T4) in it free form (0.44, 0.42, and 0.37 ng/dl) was similar among treatments. The CAM fed heifers tended (p= 0.09) to have less of the other thyroid hormone of interest triiodothyronine (T3) (144.7, 157.5 and 154.5 ng/dl). This indicates that the low concentration of glucosinolates in the CAM diet may have still influenced thyroid function.

Overall, feeding CAM maintained frame growth and comparable ADG but decreased gain to feed compared to DDGS and LIN. The decreased feed efficiency may be related to glucosinolates. This study demonstrates that camelina meal could serve as an alternative quality protein source for growing dairy heifers and had limited adverse effects on growth performance when included at 10% of diet compared to reduced-fat DDGS and linseed meal.

3. Growth performance of dairy calves fed microbially-enhanced soy protein in starter pellets with accelerated growth or traditional milk replacer.

Our objective in this study was to evaluate growth performance of calves fed starter pellets with microbially-enhanced (fungally-treated) soy protein (MSP) compared to soybean meal and the interaction with milk replacer (MR). A 12-week randomized complete block design study was conducted with 36 Holstein calves (2 d old; 24 females, 12 males) in individual hutches. Treatments were: 1) MSP pellets with accelerated growth MR (MSPA), 2) SBM pellets with accelerated growth MR (SBMA), and 3) MSP pellets with traditional MR (MSPT). Starter pellets were similar, but had 23% MSP or 23% SBM (DM basis). Calves were fed 0.34 kg of MR during week 1 and 0.45 kg of MR during weeks 2 to 5 twice per day at 0500 and 1700 h and, 0.45 kg of MR once per day at 0500 h during wk 6. Calves were weaned at day 42. Pellets and water were fed ad libitum throughout the 12 week feeding period. Intakes and fecal consistency scores (1=firm, 4=liquid) were recorded daily.

Frame sizes and body (BW) were measured 2 consecutive days every 2 wk approximately 3 h post-feeding. Jugular blood samples for metabolite analysis were collected 2 d every 2 wk at the same time as weighing. During week 12 fecal grab samples were collect 5 times a day for 3 d and then composited for analysis of total tract nutrient digestibility. Acid detergent insoluble ash was used as an internal marker. Results were analyzed in SAS 9.4 using repeated measured in MIXED procedures and Tukey's test for means comparisons. Significance was declared at $P<0.05$.

Results (see table) showed that total dry matter intake and starter pellet dry matter intake were greatest for SBMA and least for MSPT with MSPA in between. Body weights were greatest for calves fed MSPA compared to SBMA and MSPT. Average daily gains were less for MSPT fed calves compared to MSPA with SBMA intermediary and similar to both. Gain to feed ratios were increased in the MSPA and MSPT treatments compared to SBMA. Hip heights, paunch girth and body lengths were less for MSPT, but differences were numerically small and average rates of gain for frame size measures were similar across treatments over the duration of the feeding period. Plasma glucose concentration similar among treatments. Plasma urea nitrogen (PUN) concentration were greatest for MSPA fed calves and least for the MSPT. Beta hydroxyl butyric acid (BHBA) was greatest for the SBMA fed calves most likely due to greater starter pellet intakes. Concentration of plasma triglycerides was slightly greater in calves fed the MSPT treatment. The greatest concentration of IGF-1 was observed in the calves receiving SBMA compared to MSPA and MSPT and may also be related to increase DMI on that treatment. Total tract digestibility of dry matter and neutral detergent fiber were similar across treatments, but calves fed MSPT had greater digestion of crude protein and acid detergent fiber compared to calves fed SBMA with MSPA being in the middle and similar to both. Overall incidences of scouring (diarrhea) were low and fecal consistency scores averaged 1.16 (meaning firm consistency) across treatments.

Overall results demonstrated an additive benefit of feeding calves accelerated growth MR with MSP pellets on body weight gain and gain: feed. Calves fed MSPT had comparable growth performance to calves fed SBMA, with increased gain to feed ratio, especially after weaning. Utilizing MSP in calf starters pellets results in decreased DMI, improved feed efficiency and maintained or enhanced growth performance compare to SBM.

Item	Treatment			
	MSPA	SBMA	MSPT	SEM
Total DMI, g/d	1,650.1^{b}	1,758.7^{a}	1,386.7^{c}	39.59
Starter DMI, g/d	1,271.5^{b}	1,380.4^{a}	1,010.4^{c}	40.84
BW, kg	72.59^{a}	68.53^{b}	67.75^{b}	3.99
ADG, kg/d	0.68^{a}	0.63^{ab}	0.59^{b}	0.04
Gain: Feed	0.46^{a}	0.41^{b}	0.47^{a}	0.02
Digestibility of DM, %	81.0	80.3	84.8	1.58
Digestibility of CP, %	86.4^{ab}	85.1^{b}	89.7^{a}	1.37
Glucose, mg/dl	98.83	101.38	99.86	1.76
BHBA, mg/dl	34.48^{ab}	35.55^{a}	31.77^{b}	1.27
Triglyceride, mg/dl	25.20^{b}	27.74^{b}	28.78^{a}	1.09
PUN, mg/dl	15.58^{a}	14.23^{b}	12.78^{c}	0.35
IGF-1, ng/ml	63.75^{b}	73.26^{a}	60.46^{b}	3.04

^{abc} Mean with unlike superscripts differ by $P<0.05$ using Tukey's test.

Objective 2: To optimize lactating and dry cow decision-making as it relates to animal health, nutrient utilization, milk production, reproduction, and profitability (cows).

1. Ruminal degradation and intestinal digestibility of camelina and carinata meal compared to other protein sources.

Our objective in this study was to determine dry matter (DM) and crude protein (CP) ruminal degradability and intestinal digestibility of camelina meal (CAM) and carinata meal (CAR) compared to other oilseed meals, soybean meal (SBM) and reduced-fat distillers dried grains (DDGS). In situ measurements were done using three multiparous, ruminally-cannulated Holstein cows (BW 848.6 ± 94.7 kg). Six feeds were evaluated: CAM, CAR, canola meal (CAN), linseed meal (LIN), DDGS, and SBM. Duplicate 5 g samples were weighed into 10 × 20 cm nylon bags and ruminally incubated for 0, 2, 4, 8, 12, 24 and 48 h. Six additional bags of each feed were incubated at 12 h for use in determination of in vitro intestinal digestibility of CP. Residues were incubated with pepsin and pancreatin solutions for 1 h and 24 h, respectively. Rumen degradation constants for DM and CP were estimated using the NLIN procedures in SAS 9.3. Intestinally digestible protein (IDP), intestinally absorbable dietary protein (IADP = ruminally undegradable protein (RUP) × IDP), and total digestible protein (TDP = ruminally degradable protein (RDP) + IADP) were evaluated using MIXED procedures in SAS 9.4.

Result demonstrated that ruminally degradable DM (RDDM) was greatest in CM, CR, and SBM. The CM and CR had the greatest RDP and least RUP of the feeds. The IDP was less in CM and CR compared to SBM and LN, but greater than CN and DG. The CR and CM had less IADP compared to the other feeds. The TDP was similar for CM and CR compared to SBM and LN, but greater than CN and DG. Overall, results indicate that CM and CR are highly degradable in the rumen and are comparable protein sources to SBM and LN for total digestibility.

	Feedstuffs						
Item	CM	CR	CN	LIN	DG	SBM	SEM
CP, % DM	40.9	43.9	45.3	40.4	35.0	53.9	-
RDDM, % of DM	65.0^{a}	63.0^{a}	50.9^{c}	55.8^{b}	50.8^{c}	65.0^{a}	0.64
RDP, % of CP	76.4^{a}	70.5^{b}	52.0^{d}	61.2^{c}	44.1^{e}	58.4^{c}	0.95
RUP, % of CP	23.6^{e}	29.4^{d}	48.0^{b}	38.8^{c}	55.9^{a}	41.6^{c}	0.95
IDP, % of RUP	80.9^{b}	80.9^{b}	70.9^{c}	81.6^{b}	63.2^{c}	90.5^{a}	2.61
IADP, % of CP	19.1^{c}	23.8^{c}	34.0^{ab}	31.7^{b}	35.4^{ab}	37.6^{a}	1.42
TDP, % of CP	95.5^{a}	94.4^{a}	86.0^{b}	92.9^{a}	79.5^{c}	96.0^{a}	1.22

^{abcde} Values with unlike superscripts differ by $P < 0.05$.

2. **Ensiling carinata meal with forages to decrease of glucosinolate concentrations.** Carinata meal (CM) has high quality protein, but it also has high concentration of sinigrin, a glucosinolate, which limits its use as a feedstuff. Our objective was to determine if ensiling CM with forages would decrease sinigrin concentration without compromising fermentation. Two trials were conducted, one on ensiling CM with alfalfa haylage (AH) and one with corn silage (CS). For both trials three blends of CM to forage were made 0:100, 25:27, and 50:50 on a DM basis. For both approximately 637g of DM

for each the three blends were packed in 942 cm^3 microsilos in quadruplicate for 0, 7, 21 and 60 d of ensiling.

Findings showed that sinigrin the major glucosinolate in carinata meal was greatest ($P < 0.01$) in the 50:50 and decreased over time ($P < 0.01$) in the 25:75 and 50:50 in both trials. There was no treatment by d interaction for AH blends, but there was a treatment by d interaction for the CS blends. The pH decreased in all blends over time, but was greater in the 50:50 compared to the other blends. Acetic acid and Lactic acid increased over time in all blends. Acetic acid was less in the AH blends with increased CM. There was no treatment effect on acetic acid for the CS blends. Lactic acid was less in both trials with increased inclusion of CM. In both trials CP increased with inclusion of CM. The CP was similar over d of ensiling in AH blends, but tended ($P=0.05$) to decrease over d in CS blends. In both trials, NDF was less with the addition of the CM and there was a treatment by d interaction ($P < 0.01$) in CS trial, and a tendency ($P = 0.08$) for interaction in the AH trial. Ensiling CM with forage decreases glucosinolate concentrations, without major detriment to silage fermentation.

		Treatment				P values		
Item, % DM	Blend	0:100	25:75	50:50	SEM	Trt	d	Trt × d
Sinigrin, mg/g	AH	-	2.24	5.78	0.13	<0.01	<0.01	0.65
	CS	-	3.67	7.12	0.17	<0.01	<0.01	<0.01
pH	AH	4.89	4.83	5.00	0.02	<0.01	<0.01	<0.01
	CS	3.96	4.23	4.47	0.04	<0.01	<0.01	0.90
Acetic Acid	AH	1.32	1.05	0.75	0.04	<0.01	<0.01	<0.01
	CS	0.89	0.96	0.94	0.03	0.22	<0.01	0.61
Lactic Acid	AH	3.71	2.57	1.77	0.07	<0.01	<0.01	<0.01
	CS	2.64	2.35	2.16	0.05	<0.01	<0.01	<0.01
CP	AH	24.6	29.6	32.6	0.96	<0.01	0.20	0.09
	CS	6.2	15.6	25.0	0.28	<0.01	0.05	0.19
NDF	AH	38.5	34.8	31.8	0.25	<0.01	<0.01	0.08
	CS	33.9	30.4	28.7	0.22	<0.01	0.05	<0.01

D. Usefulness of findings:

Research findings are contributing to developing new feeding guidelines for feeding reduced-fat distillers dried grains (RFDDGS) to growing dairy replacement heifers. Result show that RFDDGS can be fed in total replacement of traditional more expensive concentrate ingredients and that by feeding greater proportion of the ration in replacement of forage better feed efficiency can be achieved without compromising growth performance of dairy replacements.

Camelina meal and carinata meal are two new potential biofuel co-products that show potential as protein sources for dairy cattle, if glucosinolates can be decreased. Development of new biofuel crops with different agronomic characteristics is important to sustainability of the biofuel industry and offer new novel feedstuffs or co-products for use as livestock feeds. Ensiling oilseed meals with forages may offer an on-farm processing method to decrease glucosinolates.

Microbially-enhanced (fungally-treated) plant protein sources like soybean meal are well utilized by dairy calves and enhance feed efficiency compared to untreated protein sources. Microbially-enhanced feeds may best be utilized by young dairy calves as rumen development is still in progress.

E. Publications:

Peer-reviewed Journal Articles

1) Anderson, J.L, K.F. Kalscheur, A.D. Garcia, and D.J. Schingoethe. 2015. Feeding fat from distillers dried grains with solubles to dairy heifers: I. Effects on growth performance and total tract digestibility of nutrients. J. Dairy Sci. 98:5699-5708.

2) Anderson, J.L., K.F. Kalscheur, J.A. Clapper, G.A. Perry, D. H. Keisler, A.D. Garcia, and D.J. Schingoethe. 2015. Feeding fat from distillers dried grains with solubles to dairy heifers: II. Effects on metabolic profile. J. Dairy Sci. 98:5709-5719

3) Anderson, J.L., K. F. Kalscheur, A. D. Garcia, and D. J. Schingoethe. 2015. Short Communication: Feeding fat from distillers dried grains with solubles to dairy heifers: III. Effects on post-trial reproductive and lactation performance. J. Dairy Sci. 98:5720-5725.

4) Anderson, J.L., K. F. Kalscheur, A. D. Garcia, D. J. Schingoethe, D. P. Casper, and D. H. Kleinschmit. 2015. Ensiling characteristics of distillers wet grains with cornstalks and determination of the feeding potential for dairy heifers. Prof. Anim. Sci. 31:359-367.

Abstracts

1) Casperson, J.L., J.L. Anderson, J.R. Croat, W.R. Gibbons. 2015. Ruminal degradation and intestinal digestibility of microbially-treated soybean meal and dried distillers grains compared to the original feeds. J. Dairy Sci. 98: Suppl. 2: 460 (Abstr. T418).

2) Jayasinghe, N.K., K. F. Kalscheur, J. L. Anderson, and D. P. Casper. 2015. Canola meal in dairy cow diets with varying concentration of starch sources. J. Dairy Sci. 98: Suppl. 2: 128 (Abstr. M340)

3) Lawrence, R. D. and J. L. Anderson. 2015. Ruminal degradation and intestinal digestibility of camelina and carinata meal compared to other protein sources. J. Dairy Sci. 98: Suppl. 2: 459 (Abstr. T416)

4) Lawrence, R. D., and J. L. Anderson. 2015. Evaluation of camelina meal as a feedstuff for growing dairy heifers. Journal of Dairy Science. J. Dairy Sci. 98: Suppl. 2: 463 (Abstr. T426)

5) Manthey, A. K., J. L. Anderson, G. A. Perry. 2015. Growth performance of dairy heifers fed reduced-fat distillers grains in replacement of forage in limit-fed rations. J. Dairy Sci. 98: Suppl. 2: 459 (Abstr. T415).

6) Manthey, A. K., J. L. Anderson, G. A. Perry, and D. H. Keisler. 2015. Metabolic profile and onset of puberty in dairy heifers fed reduced-fat distillers grains in replacement of forage. J. Dairy Sci. 98: Suppl. 2: 735 (Abstr. W329).

7) Rodriguez-Hernandez, K., J. L. Anderson, and M. A. Berhow. 2015. Ensiling carinata meal with forages to decrease glucosinolate concentrations. J. Dairy Sci. 98: Suppl. 2: 475 (Abstr. T459).

8) Wild, B. J., J. L. Anderson, and A. D. Garcia. 2015. Ruminal degradability and intestinal digestibility of crude protein in sorghum distillers dried grains compared to soybean meal and corn co-products. J. Dairy Sci. 98: Suppl. 1:158 (Abst. 355) (Midwest ASAS/ADSA).

Thesis

1) Lawrence, R.D. 2015. Evaluation of the potential for use of non-food oilseed meals as feedstuffs for growing dairy heifers. M.S. Thesis, South Dakota State University, Brookings. *(in final preparation - Fall 2015)*

F. Impact statement:

Research conducted at South Dakota State University demonstrated that:

- Reduced-fat distillers dried grains can be fed to group at up to 50% of limit-fed rations with no impacts on growth performance and increased feed efficiency. However, there were some changes in metabolic profile and on-set of puberty among different feeding rates.
- Growth performance of dairy heifers was maintained but not improved by feeding camelina meal compared to distillers dried grains or linseed meal at 10% of the diet. Despite moderate inclusion rate and high quality protein of the camelina meal, glucosinolates may have compromised growth performance as indicated by a tendency for decreased thyroid hormone.
- Inclusion of microbially-enhanced soy protein (fungally-treated) in calf starter pellets improved feed efficiency and starter pellet utilization by decreasing pellet intake while increasing average daily gain compared with regular soybean meal.
- The crude protein content of camelina meal and carinata meal have large proportions of rumen degradable protein and are comparable to soybean meal and linseed meal for concentration of total digestible protein. Camelina and carinata meal are more degradability and digestible compared to distillers grains and canola meal.
- Ensiling brassica oilseed meals with haylage or corn silage shows potential as an on-farm processing method to decrease glucosinolates.

G. Leverage:

Feeding non-food oilseed meals to dairy heifers. $25,000.

Feeding micobially-enhanced soy protein to dairy calves. $37,000.

NC2042: 2014-2015 Annual Report

University of Illinois at Urbana-Champaign

Management Systems to Improve the Economic and Environmental Sustainability of Dairy Enterprises.

Personnel: Felipe (Phil) Cardoso (Project Leader), Cassandra Fox (MS student; graduated summer 2015), Katie Haerr (MS student; graduated spring 2015), Saige Sulzberger (MS student), M. Ines Rivelli (MS student), Caroline Kalebich (MS student), Stephanie Stella (MS student), and Maegan Weatherly (PhD student).

Collaborators: James K. Drackley, Romana A. Nowak, Matthew B. Wheeler, J. Loor, and D. W. Shike, University of Illinois; D. H. Keisler, University of Missouri; Leo Timms, Iowa State University; and J. R. Roche, Dairy NZ, New Zealand.

Main objective: To evaluate and develop sustainable management systems for dairy herds that address critical quality and variance control factors with implications to economic efficiencies and environmental impacts.

Specific objectives:

1) Optimize calf and heifer performance through increased understanding of feeding strategies, management systems, well-being, productivity and environmental impact for productivity and profitability.
2) Improve dairy cow management decisions through nutrient utilization, well-being and profitability.
3) Analyze whole farm system components and integrate information into decision-support tools to improve efficiency, enhance profitability, and environmental sustainability.

Work progress and principal accomplishments:

Under objective 1.

Effects of Three Tail Painting Formulations on Behavior of Dairy Heifers. C. S. Skenandore *[1] and F. C. Cardoso[1], [1]*University of Illinois, Urbana.* Studies have shown that the correct use of tail paint can identify almost 90% of cows in standing heat. To investigate the potential relationship among the utilization of different formulations of commercially available tail paint and their effectiveness in heifers, 18 Holstein heifers at breeding age were selected, balanced by age (13.7 ± 1.2 months), body weight (394±32 Kg), and body condition score (3.43±0.1 on a 1 to 5 scale), and randomly assigned to one of three treatment groups. Experimental treatments were: Control (CON), orange color, tail chalk, commercial formulation; Treatment A (TRTA), orange color, tail chalk, new formulation; and Treatment B (SPRAY), orange color, spray formulation.

Experimental design was a Replicated 3x3 Latin square design with 6 total squares, 3 animals per square. Each period was 14 d. Visual observations were performed for tail paint licking (LICK; being licked at the tail paint), social licking (SOCLICK; being licked at the head, neck, or leg areas), rump licking (RUMPLICK; being licked at the rump area), and product disappearance (TPREMOVED; score from 0 to 2 according to the degree of tail paint removal) in 30-minute segments every 2 hours from 6AM to 6PM. Video recordings were used to confirm observations. The outcome variables of interest LICK, SOCLICK, and RUMPLICK were summarized to daily counts of interactions. Assessment of TPREMOVED was done once daily before subsequent treatment application. A synchronization protocol (Ovsynch®: 100mg GnRH, then 25mg PGF2α 7d later, and 100mg GnRH 2d after PGF2α) was used to stimulate high and low social interactions. Statistical analyses were performed using the GLIMMIX procedure of SAS (SAS v9.3 Institute Inc. Cary, NC, USA). Half of the heifers (51.4%) received at least one SOCLICK, but only 10.1% of the heifers received a RUMPLICK. There were no treatment differences for SOCLICK (P>0.88) or RUMPLICK (P>0.42). The majority (75.3%) of the heifers did not receive LICK and less than 2% of the heifers received more than one LICK. Heifers receiving SPRAY had lower number of LICK per day (P=0.005) when compared to CON or TRTA. Heifers that received SPRAY had less TPREMOVED (P=0.0001) when compared to CON or TRTA, and TRTA heifers had less TPREMOVED (P=0.01) when compared to CON. In conclusion, SPRAY had lower number of LICK and lower TPREMOVED. Licking behavior seen on commercial dairy farms may be primarily from social licking rather than tail paint licking.

Behaviors of Holstein heifers associated with large follicles during the estrous cycle. C. S. Skenandore *[1] and F. C. Cardoso[1]. [1]*University of Illinois, Urbana, Illinois.* Estrus detection in heifers is pivotal for reproductive success. The objective of this study was to identify behaviors associated with 2 different periods of the estrous cycle of Holstein heifers. Eighteen heifers at breeding age were selected, balanced by age, BW, and BCS (average 13.7 ± 1 mo, 394 ± 32 kg, and 3.43 ± 0.1 respectively), and observed for 6 wk. The experimental period was divided into 3 periods of 14 d each. All heifers received the same basal diet to meet requirements (NRC 2001), fed once daily. Visual observations were performed in 30 min segments every 2 h from 6AM to 6PM. Video recordings were used to confirm observations. Twelve behaviors were recorded (Social Lick, Rump Lick, Tail Paint Lick, Body Butt, Head Butt, Push, Chin Rest, Anogenital Sniff, Play Rub, Winner, Mount, and Attempt Mount). A synchronization protocol starting on d 1 of each period (Ovsynch: 100mg GnRH at d 1, 25mg PGF2α at d 7, and 48 h later an application of 100mg of GnRH) was used to stimulate periods of high and low interactions. Observations were summarized to daily counts of interactions for each behavior. Ovaries were examined via ultrasound imaging on d 1, 8, and 10 of each period. The presence of follicles or a corpus luteum (CL) was recorded with their respective sizes. Lying time, standing time, and bouts /d were recorded using accelerometers (Onset HOBO Pendant G) at 1 min intervals for 14 d. Statistical

analyses were performed using the GLIMMIX procedure of SAS (v9.3). During periods of low activity per the synchronization protocol, social ($P < 0.01$) and paint ($P < 0.05$) licking were more likely to be expressed than estrus-related behaviors such as rump licking ($P < 0.05$), chin resting ($P < 0.002$), and mounting ($P < 0.003$). The aforementioned estrus related behaviors were also performed in more frequency than other behaviors when a large follicle is present ($P < 0.03$). Heifers spent more time standing and less time lying per day when they had a large follicle ($P < 0.006$) compared with a small follicle. In conclusion, increased activity and specific behaviors may be used in the future to facilitate estrus detection in heifers.

Effects of alfalfa hay and its physical form (chopped versus pelleted) on performance of Holstein calves. M. Jahani-Moghadam,* E. Mahjoubi,† M. Hossein Yazdi,† F. C. Cardoso,‡ and J. K. Drackley‡.*Department of Animal Science, University of Agriculture and Natural Resource Science of Sari, Sari, Iran. †Department of Animal Science, University of Zanjan, Zanjan, Iran. ‡Department of Animal Sciences, University of Illinois, Urbana. Inclusion of forage and its physical form in starter may affect rumen development, average daily gain (ADG), and dry matter intake (DMI) of dairy calves. To evaluate the effects of forage and its physical form (chopped vs. pelleted) on growth of calves under a high milk feeding regimen, 32 Holstein calves (38.8 ± 1.1 kg) were assigned at birth to 1 of 3 treatments in a completely randomized block design. Dietary treatments (% of dry matter) were (1) 100% semi-texturized starter (CON); (2) 90% semi-texturized starter + 10% chopped alfalfa hay (mean particle size = 5.4 mm) as a total mixed ration (TMR; CH); and (3) 90% semitexturized starter + 10% pelleted alfalfa (mean = 5.8 mm) hay as a TMR (PH). Data were subjected to mixed model analysis with contrasts used to evaluate effect of forage inclusion. Calves were weaned at 76 d of age and the experiment finished 2 wk after weaning. Individual milk and solid feed consumption were recorded daily. Solid feed consumption and ADG increased as age increased (effect of week), but neither forage inclusion nor physical form of forage affected these variables pre- or postweaning. Plasma urea N was affected by treatments such that the CON group had a lower concentration than forage-fed groups. Forage inclusion, but not physical form, resulted in increased total protein in plasma. Although days with elevated rectal temperature, fecal score, and general appearance were not affected by dietary treatments, calves fed alfalfa hay during the first month of life had fewer days with respiratory issues, regardless of physical form of hay. We concluded that provision of forage does have some beneficial effects in calves fed large amounts of milk replacer, but pelleted alfalfa hay did not result in any improvement in calf performance or health.

Under objective 3

Bedding characteristics are associated with milk quality in Illinois dairy farms: A Dairy Focus Team approach. Maria I. Rivelli*1, Katie J. Haerr1, Sarah Y. Morrison1, Saige A. Sulzberger1, Cassandra S. Skenandore1, Leo L. Timms2, and Felipe C. Cardoso1. 1 University of Illinois, Urbana, IL. 2 Iowa State University, Ames, IA. The ultimate goal of this project is to improve Illinois dairy farms through education, accomplished through the science based innovation of the University of Illinois research and extension. The specific aim of this study was to investigate the association between bedding material and milk quality of dairy cows. Twenty dairy farms in Illinois located in the central (C), north (N), and south (S) regions were visited. During the visits, a questionnaire, DHI records along with the individual farm data set (PCDART or DAIRYCOMP305) were collected and a final data set with the combined information was built in excel for analysis. Cow's bedding sample was a composite sample made from 3 different spots in the bed (front, center, and back). Bedding quality was evaluated by quantifying dry matter (DM) percentage, organic matter (OM) percentage, and particle size (PS). Dry matter analysis was performed in all types of bedding; OM and PS analyses were performed only in sand bedded farms (n = 12). Three replications for each sample were performed for PS to obtain particle size (μm), standard deviation, and particles per gram (p/g). Statistical analysis was performed using the UNIVARIATE and GLM procedures of SAS (v9.4). Sixteen farms (80%) used sand bedding; 32% of those farms combined sand with a different type of bedding such as straw or compost. Among the other 4 farms (20%), there were 2 farms (10%) with straw bedding, 1 farm (5%) was using sawdust, and only one farm (5%) had their cows on pasture. Differences for DM and OM were found between and within regions. On average the 12 farms that used sand as bedding had a 92 ± 8% of DM, 3 ± 2.7% of OM, milk yield per cow/d was 35.17 ± 6kg, and somatic cell count (SCC) tank was 204 ± 91 cells/mL. However there was a linear correlation (P = 0.05, R2 = 0.32, SCC = 16.28OM +134.1) between OM and SCC, and no correlation (P = 0.3827) between DM and SCC, Southern IL had lower DM (88.4 ± 9) and OM (1.9 ± 0.8) percentage and higher somatic cell count (261.2 ± 179) than N or C. In conclusion, our results confirm the premise that farms with high OM bedding are associated with higher milk tank SCC.

Reproductive performance in dairy farms throughout Illinois: A Dairy Focus Team approach. Maria I. Rivelli*1, Tonja Egan1, Diego A. Velasco Acosta1,2, Katie J. Haerr1, Sarah Y. Morrison1, Saige A. Sulzberger1, Cassandra S. Skenandore1, and Felipe C. Cardoso1. 1 University of Illinois, Urbana, IL, 2 Universidade Federal de Pelotas, Pelotas, Brazil. The ultimate goal of this project is to improve Illinois dairy farms through education. This is accomplished through the science-based innovation of the University of Illinois research and extension, and also gives students hands-on experience evaluating commercial dairy farms. Fertility in dairy cows has been declining in recent years. Therefore, the specific aim of this study was to survey the association between milk yield and reproductive status of dairy cows in selected dairy farms in Illinois. Twenty dairy farms in Illinois located in the central (C), north (N), and south (S) regions

were visited. During the visits, a questionnaire, DHI records along with the individual farm data set (PCDART or DAIRYCOMP305) were collected and a final data set with the combined information was built in Excel for analysis. Yearly pregnancy rates (PR), first service conception rate (FSC), and services per conception (SC) were assessed on cows and heifers from 12 farms. Statistical analysis was performed using the UNIVARIATE procedure in SAS (v9.4). Heifer's PR average overall was 14 ± 8.4%, and cow's PR was 16.7 ± 4.9%. As expected, FSC was higher for heifers (56.5 ± 16.5%) than cows (40.8 ± 9.0%). Heifer's SC was 2.2 ± 1.4, and cow's was 2.6 ± 0.6, and average milk yield per cow/d was 35.3 ± 6.1kg. In Northern Illinois, heifer's PR was higher (20.2 ± 4.3%) than Central Illinois (13.5 ± 8%). Furthermore, in Northern Illinois cow's PR was higher (19.2 ± 4.9%) than Central Illinois (17.7 ± 2.6%). Moreover, similar differences were found for FSC, and SC. Average milk yield per cow/d was 38.0 ± 6.6 kg for N; 32.9 ± 5.6 kg for C; and 36.2 ± 6.4 kg for S. In conclusion, there were differences for PR, FSC, and SC percentages between and within regions. These results collectively, although limited in sample size, suggest that geographical aspects may play a role in reproductive success in Illinois dairy farms. The results of this study would imply customized recommendations to each farm to improve its reproductive status.

Usefulness of findings:

Licking behavior of dairy heifers seen on commercial dairy farms may be primarily from social licking rather than tail paint licking. The increased activity and specific behaviors from heifers may be used in the future to facilitate estrus detection in heifers. For calves under high levels of milk feeding, forage supplementation had little effect on intake, ADG, or efficiency. Pelleting hay produced no benefit over chopping hay. Small changes in blood variables indicated that there were alterations in rumen or systemic metabolism that were positive or neutral to calves. The results from a survey of dairy farms in IL collectively, although limited in sample size, suggest that geographical aspects may play a role in reproductive success in Illinois dairy farms. The results of this study would imply customized recommendations to each farm to improve its reproductive status. Additionally, dairy farms with bedding material (sand) containing high organic matter were associated with higher milk tank SCC.

Producer interactions (extension activities)

1) F.C. Cardoso. 2015. Besides visiting 20 farms in IL during the summer of 2014, the results were presented at the Dairy Summit in January 2015 (Centralia, Bloomington, and Freeport) for more than 400 Illinois dairy farmers.
2) F.C. Cardoso. 2015. Transitioning with Ease. PDPW Transition Cow Conference. April 7-9, Appleton, Fennimore, and Eau Claire, WI. Role: speaker. Audience: dairy producers, dairy industry representatives, and consultants. 400 attendees.

3) F.C. Cardoso. 2015. Presented data at the 4 State Dairy Nutrition and Management conference in Dubuque Iowa for more than 500 people (dairy farmers and stakeholders) mainly from Wisconsin, Illinois, Iowa, and Minnesota.

Publications

Full-Length Articles

1) Drackley, J. K. and F. C. Cardoso. (2014). Prepartum and postpartum nutritional management to optimize fertility in high-yielding dairy cows in confined TMR systems. Animal, 8:S1, 5-14.
2) Jahani-Moghaddam, M., E. Mahjoubi1, M. Hossein Yazdi, F. C. Cardoso, J. K. Drackley. (2015). Effects of alfalfa hay and its physical form (chopped vs. Pelleted) on performance of Holstein calves. J. Dairy Sci. 98(6):4055-61.

Popular Press

- Articles in Hoards Dairyman, Progressive Dairymen, Midwest Forage Association, Illinois Milk Producer's Association Newsletter, and Dairy Focus Newsletter (More at: http://dairyfocus.illinois.edu)

MINNESOTA
OBJECTIVE 1

Annual Project Report – Cooperative Regional Project NC-2042
Year ending September 30, 2015
(Not for Publication)

A. Project Title: "Management Systems to Improve the Economic and Environmental Sustainability of Dairy Enterprises"

Project Objectives

Objective 1: Optimize calf and heifer performance through increased understanding of feeding strategies, management systems, well-being, productivity and environmental impact for productivity and profitability**.**

Objective 2: Improve dairy cow management decisions through nutrient utilization, well-being and profitability.

Minnesota contribution at Waseca to Objective 1.

B. Cooperating Agencies: Dept. of Animal Science , University of Minnesota, St. Paul; University of Minnesota Research and Outreach Centers at Morris (WCROC) and Waseca (SROC); AllTech Hubbard Feeds Inc., Mankato, MN; Milk Products, Chilton, WI; Milk Specialties, Eden Prairie, MN; International Ingredients Corporation, St. Louis; AURI, Waseca.

Personnel: H. Chester-Jones, M. Endres, D.M. Ziegler, B. Ziegler, D. Schimek, B. Heins ,D. Cook, M. Thornsberry, C. Soderholm, N. Broadwater, D. Dean, K. Halpin,

C. Progress of Work and Accomplishments:

Brief overview - Program focus with the SROC Calf and Heifer Research and Extension Facility (CHREF) since 2004 has been with commercial dairy heifer calves from 3 dairies representing over 2,000 dairy cows. Calves are picked-up twice weekly at 2-5 days of age. All calves receive 3 feedings of colostrum by 24 hours of age. During the project year 2013-2014, > 1,000 heifer calves have been raised for the 3 dairies. The overall death loss to date for the 10,809 calves that have arrived at SROC is 2.1%. One of the unique aspects of the project is the development of Excel spreadsheets for each dairy tracking every calf that enters and leaves SROC then follow them back to the dairies for first lactation production data.

A target goal for calf performance in the nursery phase is to double the initial body weight by the end of the nursery phase and gain at least 4 inches of frame height in the same time period. It has been suggested that during the first 2 weeks in the nursery a goal is to attain 1 lb/day daily gain to aid in calf health. These goals have been attained in a number of calf groups but there are some variations by season of the year. Prior to February 2010, MR were medicated with 2:1 neomycin (400g/ton):oxytetracycline (200 g/ton; unless noted otherwise). Since 2010, calves have been fed a non-medicated MR supplemented with 1:1 higher concentration of neomycin:oxytetracycline (1600g/ton) for the first 14 days. For a number of studies no antibiotic supplements have been used with non-medicated MR. In the winter months the volume of MR may be increased based on the

ambient temperature taken in the morning. This adjustment only occurs from 0º F and below. Calves will remain in their respective pens until 2 weeks after weaning and then transfer to group pens of 6-8 heifers. Occasionally calves have remained in the nursery for up to 70 days. At least 20-25 calves are assigned for each treatment group for nursery studies.

Automatic calf feeding system in a renovated calf room. An Urban automatic calf feeding system at SROC has been functional since September 2011 in a renovated calf room. Calves are placed into the AFR upon arrival to SROC. The Urban feeder is capable of feeding the same or two different milk replacers independently to calves co-mingled in two pens of 23 (32 sq ft/calf).

This past year, calves in the auto feeder room have been involved in a number of demonstration projects including calf starter preference and milk replacer options.

Current or recently completed studies.

A. Metanalyses (current)

Two projects are on-going using the data set from the 3 commercial dairies:

- **To understand the relationship between calf growth and health across multiple studies to first lactation performance.**

- **To evaluate the relationships between protein and energy intake during the nursery phase on performance parameters for all calves assigned to studies is being conducted by graduate student Jessica Rauba** (co-advised by Heins and Chester-Jones).

B. Effects of cinnamaldehyde on performance of post-weaned dairy heifers (completed)

The objectives of this study are to provide dairy producers an alternative to using ionophores for improving feed efficiency and health in post-weaned dairy heifers.

Prior to the study all heifers will have been fed a 16% CP corn and pellet grain mix containing 30 g/ton monensin at 6 lb/head daily with access to free choice hay then transitioned to the 4 treatments which include:

1. (3 pens of 7 heifers/pen; total = 21; control) 16% CP corn and pellet grain mix fed at 5 lb/head daily for 70 days with free choice hay; an unsupplemented ground corn carrier at 2 lbs/pen will be top dressed and mixed into the grain mix daily;

2. (3 pens of 7 heifers/pen; total = 21; monensin) 16% CP corn and pellet grain mix same as treatment 1 fed at 5 lb/head with free choice hay; the ground corn carrier will include monensin at 1 mg/kg of heifer body weight adjusted bi-weekly and top dressed and mixed into the grain mix daily as in treatment 1.

3. 3 pens of 7 heifers/pen; total = 21; cinnamaldehyde-A) 16% CP corn and pellet grain mix fed as in treatments 1 and 2 fed at 5 lb/head daily; the ground corn carrier will include cinnamaldehyde at 1 mg/kg of heifer body weight adjusted bi-weekly and top dressed and mixed into the grain mix daily as in treatments 1 and 2.

4. (3 pens of 7 heifers.pen; total = 21; cinnamaldehyde-B) 16% CP corn and pellet grain mix fed as in treatments 1, 2 and 3. the ground corn carrier will include cinnamaldehyde at 2 mg/kg of heifer body weight adjusted bi-weekly and top dressed and mixed into the grain mix daily as in treatments 1, 2 and 3.

C. Performance and Health of Calves Pre- and Post-Weaning Fed Whole Milk and whole milk supplemented with Differing Milk Replacer Protein Sources (current.)

Treatments	**1**	**2 -AM**	**3 - SWP**	**4 – PP**
Whole Milk (WM) Diet, %	**100%**	**66.7%**	**66.7%**	**66.7%**
Milk Replacer Diet, %	**None**	**33.3%**	**33.3%**	**33.3%**
Protein Sources	WM	100% Milk Protein	50% Soy Protein Concentrate/Wheat Protein Blend 50% Milk Protein	50% P80 Protein 50% Milk Protein
# Per Treatment	25	25	25	25
Day 1-35[ad] total Milk Solids, lbs	1.50	1.50	1.50	1.50
Day 1-35 solids from whole milk, lbs	**1.5**	**1.0**	**1.0**	**1.0**
Day 1-35 solids from milk replacer Balancer, lbs	**0**	**0.50**	**0.50**	**0.50**
Day 36-42 total Milk Solids, lbs	0.75	**0.75**	0.75	**0.75**
Day 36-42 solids from whole milk, lbs	**.75**	**0.50**	**0.50**	**0.50**
Day 36-42 solids from milk replacer balancer, lbs	**0**	**0.25**	**0.25**	**0.25**
Starter[B] Crude Protein	18%	18%	18%	18%

D. Performance and Health of Calves Pre- and Post-Weaning supplemented with Algae (current).

Treatments	1-Control	2- 2 gm	3- 4 gm	4- 6 gm
Milk Replacers	24-20	24-20	24-20	24-20
Product #	37598	37598	37598	37598
Algae, gm per feeding[a]	0	1.0	2.0	3.0
# Per Treatment	25	25	25	25
D1-35[c] Milk Replacer lbs	1.50	1.50	1.50	1.50
Water lbs d1-35	10.50	10.50	10.50	10.50
Total Milk Solution Fed d1-35, lbs	12	12	12	12
d36-42[b] Milk Replacer lbs	0.75	0.75	0.75	0.75
Milk Solution lb d36-42	6.0	6.0	6.0	6.0
Milk Replacer Solids %	12.5%	12.5%	12.5%	12.5%
Total lbs Milk Replacer To Order	1800 lbs	1800 lbs	1800 lbs	1800 lbs

E. Performance of Calves Pre- and Post-Weaning Fed Texturized Calf Starters with Differing Protein Levels on a higher protein milk replacer in the First Two Months of Life (current)

All calves will be fed a 24:20 non medicated milk replacer.

Treatments	**1**	**2**	**3**	**4**
Starters	**Elite 15%**	**Elite 18%**	**Elite 21%**	**Elite 24%**
Additive Level gm/ton	45.4	45.4	**45.4**	**45.4**
Active Ingredient	decoquinate	decoquinate	decoquinate	decoquinate
Milk Replacer Feeding Schedule[a]				
Days 1-35	2x/day	2x/day	2x/day	2x/day
Days 36-42	1x/day	1x/day	1x/day	1x/day
Day 43	weaned	weaned	weaned	weaned

a- All calves will be fed 1.5625 lb of milk replacer powder reconstituted to a 12.5% milk replacer solution (5 quarts) split in two 2 feedings daily through 35 days of age and be fed according to the feeding schedule chart above. On days 36-42, all calves will be fed 0.78125 lbs of milk replacer reconstituted to a 12.5% solution and be fed 1x per day. (2.5 quarts)

b- Milk replacer feeding rate will be adjusted based on outside temperature (near calf barns) determined every day at 8am. If temperature is between 0°F and -9°F, the milk replacer solution feeding rate will be increased 20% over values listed in the above chart for the next two feedings. If temperature is -10 to-19°F, the milk replacer solution feeding rate will be increased 40% over values listed in the above chart for the next two feedings. If temperature is -20°F or less, the milk replacer solution feeding rate will be increased 60% over values listed in the above chart for the next two feedings.

c- All calves will be medicated with neomycin sulfate and oxytetracycline per label instructions for the first 14 days on trial.

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Abstracts presented at the 2015 JAM ADSA/ASAS Meeting in Orlando.

M268 - Effect of feeding calves waste milk on antibiotic resistance patterns of fecal *Escherichia coli*.

The use of waste milk in a calf feeding program is suspected to contribute to the development of bacterial antimicrobial resistance. Fifty-two calves allocated in individual pens were randomly assigned to milk replacer (MR) or pasteurized waste milk (pWM) fed twice daily for 42 d and once daily from d 43 to weaning (49 d). Waste milk was picked up from a local dairy farm twice weekly during the study and tested for detection of β-lactam antibiotic class from each load of milk. Fecal swabs were taken from each calf at 5 and 8 wk of age and cultured to obtain 3 *E. coli* isolates per sample. Each colony was tested for its susceptibility to 12 antibiotics by disk diffusion. Feeding practice (MR or pWM) and age (5 or 8 wk) effect on *E. coli* antimicrobial resistance were analyzed using binary logistic regressions for each antibiotic tested. Feeding practice, calf age and interaction between treatment and age were the fixed effects of the model, calf the random effect and calf age the repeated. β-lactam antibiotic residues were detected from each pWM load. Calves fed pWM had greater probability ($P < 0.05$) to have ampicillin (AMP) and cephalothin (KF) (β-lactam antibiotics) resistant *E. coli* than calves fed MR, whereas the number of *E. coli* resistant to florfenicol tended ($P = 0.07$) to be greater in calves fed pWM than in those fed MR. However, the probability of isolating *E. coli* resistant to AMP and KF tended ($P = 0.11$; $P = 0.06$) to decrease in pWM from 5 to 8 wk of age, in contrast to MR calves that had similar probability of isolating *E. coli* resistant to AMP and KF from 5 to 8 wk of age. It is concluded that treating cows with antibiotics generates antimicrobial residues in milk and feeding calves pWM triggers the presence of resistant *E. coli* in the gut of dairy calves.

M285 - Growth and behavior of group-fed dairy calves fed once or twice daily in an organic production system.

Heifer calves (n = 102) were used to evaluate the effect of once or twice daily feeding on growth and behavior of calves in an organic group management system. Calves were assigned to replicate feeding groups of 10 in super hutches by birth order, during 2 seasons from September to December 2013 and March to May 2014 at the University of Minnesota West Central Research and Outreach Center, Morris. Calves in groups were the experimental unit. Breed groups of calves were: Holsteins (HO; n = 26), crossbreds (n = 45) including combinations HO, Montbéliarde, and Viking Red selected for high production, and crossbreds (n = 31) including combinations of HO, Jersey, Normande, and Viking Red selected for robustness. Treatment groups were 1) once daily feeding (1×) or 2) twice daily feeding (2×). Calf groups were fed 6 L per calf/daily (2×, 3 L/feeding) of 13% total solids organic milk then weaned at 60 d when the group consumption averaged 0.91 kg starter/ calf daily. Body weight and hip height were recorded at birth, once/wk, at weaning, and at 90 d of age. Hobo Pendant G loggers were applied to the right rear leg of calves to measure total lying and standing time. Data were analyzed using PROC MIXED of SAS. Independent variables for analyses were the fixed effects of birth weight (co-variable), season of birth, treatment group, along with replicate as a random effect. Weaning group performance was gain per day, 1× (0.79 kg) and 2× (0.81 kg; $P = 0.33$); weaning weight, 1× (92.7 kg) and 2× (93.3 kg; $P = 0.80$); and weaning hip height, 1× (95.2 cm), and 2× (95.3 cm; $P = 0.94$). Daily gain to 90 d were 0.85 vs. 0.85 kg, and daily gain to 120 d were 0.85 vs. 0.83 kg for 1× and 2× calves, respectively ($P = 0.62$). For lying time, 1× (988 min/d) and 2× (995 min/d) were not different ($P = 0.57$) from each other. During the evening hours, the 2× calves had lower ($P < 0.01$) lying times (34 min/h for 1×; 28 min/h for 2×) per h because they were fed at 6pm every evening. In summary, group-fed calves fed once per day in an organic production had similar average daily gains and body dimensions compared with calves fed twice per day.

W395 - Pre- and post-weaning performance of dairy calves fed a milk-wheat-plasma protein milk replacer.

Traditionally, replacing a portion of milk protein in calf milk replacer (CMR) with plant and animal proteins has lowered CMR cost, but reduced calf growth performance. Newer processing methods for wheat protein have improved digestibility and when combined with bovine plasma as a partial replacement for milk protein in a CMR resulted in similar performance of calves fed an all milk protein CMR. The objective of this study was to compare performance of calves fed either a CMR containing a blend (B-CMR) of milk proteins (9% units protein), hydrolyzed wheat gluten protein (5% units protein) and bovine plasma (8% units protein) or all milk protein CMR (AM-CMR). Fifty-two 2- to 5-d-old Holstein heifer calves were randomly assigned to one of 2 CMR treatments. The B-CMR and AM-CMR were similar (DM basis) in CP (23%) and crude fat (21%) and fed at 0.54 kg DM/d (13% solids) from study d 1 to 35. Both B-CMR and AM-CMR contained Bio-Mos, ClariFly and 1600 g/ton each of Neomycin sulfate and Oxytetracycline the first 14 d of CMR feeding. BovaTec replaced oxy/neo from 15 d until weaning (d 42). From 35 to 42 d of study, CMR was fed at 0.27 kg DM/d. All calves were fed a common 22% CP (DM basis) texturized calf starter from study d 1 to 56. Data were analyzed as a randomized complete block design using PROC MIXED (SAS). Total intake of CMR DM from 1 to 42 d was similar at 20.8 kg DM with no differences in DM intake by weeks. Total calf starter DM intake from study d 1 to 42 was not different ($P > 0.05$) at 27.6 kg for AM-CMR fed calves and 25.4 kg for B-CMR fed calves. Total 56 d calf starter intake was not different between treatments at 64.6 vs. 61.1 kg DM for AM-CMR and B-CMR fed calves. Average daily gain from 1 to 42 d of study tended ($P = 0.08$) to be slightly lower for calves on B-CMR (0.69 kg/d) than calves on AM-CMR (0.75 kg/d). There was no difference ($P > 0.05$) in daily gain from 1 to 56 d between B-CMR treatment calves (0.83 kg/d) and AM-CMR treatment calves (0.87 kg/d). Fecal scores (1 normal, 4 watery) were numerically lower (1.4 vs. 1.6) from d 1 to 14 and scour days were numerically lower (1.27 vs 1.88) from d 1 to 42 for B-CMR calves than AM-CMR calves, respectively.

M398 - Pre- and postweaning performance of nursery calves offered texturized calf starters with varying protein levels for 56 days.

One hundred and four (2 to 5 d old) individually fed Holstein heifer calves (39.5 ± 0.69 kg BW) were randomly assigned to 1 of 4 treatments to evaluate pre- (d 1–42) and postweaning (d 43–56) calf performance when fed texturized calf starters varying in crude protein (CP) level. Texturized calf starter (CS) treatments were 1) 15% CP; 2) 18% CP; 3) 21% CP, and 4) 24% CP, as-fed. All calves were fed 0.28 kg of milk replacer (MR; 20% protein:20%fat) in 1.99 L water twice daily for the first 35 d and once daily from d 36 to 42. From d 1 to 14, 1:1 neomycin:oxytetracycline was added to the MR solution to provide 22 mg/kg BW/d. Calf starter and water were fed free choice throughout the trial. Linear (L) and quadratic (Q) contrasts were used to differentiate effects of CS CP level on growth performance. There were no differences among treatments in average daily gain pre- or postweaning. There was a Q effect of treatment on daily gain for d 1 to 56 ($P < 0.01$). Daily gains were 0.71, 0.76, 0.76, and 0.70 kg for the 15%, 18%, 21% and 24% CP CS treatment, respectively. There was a Q effect for hip height gain ($P = 0.02$). Hip height gains were 10.2, 11.1, 11.0 and 9.9 cm for the 15%, 18%, 21% and 24% treatments, respectively. Preweaning CS intake was similar across treatments. Postweaning CS intake linearly decreased with increasing CP levels, d 43 to 56 ($P < 0.01$) and overall ($P < 0.03$). Preweaning gain/feed increased with CS CP level up to 21% CP then decreased (Q; $P = 0.04$). A similar overall 56 d response in gain/feed occurred (Q; $P = 0.05$). Gain/feed d 1 to 56 was 0.53, 0.55, 0.56, and 0.55 kg for 15%, 18%, 21% and 24% CP treatments, respectively. Fecal scores, scouring days and treatment costs were similar among treatments. b-Hydroxybutyrate levels at 42 d were the lowest in calves fed the 15% CP CS. Calf starter intake decreased with increasing CP levels

but did not directly relate to calf performance. Under the conditions of this stud, there was no benefit of feeding CS CP levels above 21%.

M399 - Pre- and postweaning performance and health of dairy calves fed milk replacers vs. pasteurized waste milk.

The objectives of this study were to compare pre- (d 1 to 49) and post weaning (d 50 to 56) performance of calves fed a milk replacer (MR) formulated with similar crude protein (CP) and fat (F) concentrations to pasteurized waste milk (PWM) and a combination of PWM and a low (F) and high CP MR. One hundred and five (2 to 5 d old) individually fed Holstein heifer calves (38.8 ± 0.73 kg) were randomly assigned to 1 of 4 milk treatments. Milk treatments included 1) all-milk, non-medicated MR 20% CP: 20% F fed at 0.34 kg in 2.38 L of water 2x daily from d 1 to 42 and 1x daily from d 43 to weaning at d 49 (CON); 2) all-milk, non-medicated MR 26% CP: 31% F supplemented with additional fatty acids fed as in CON (MRS); 3) pasteurized waste milk 28.4% CP: 30.1% F fed as in CON, feeding rate was adjusted daily based on measured solids (PWM); 4) PWM fed 2× daily with 0.22 kg solids supplemented with 0.12 kg of an all milk non-medicated 24% CP: 7% F MR as in CON, adjusted for solids as in PWM (WMS). Calf starter (CS;18%CP) and water were fed free choice d 1 to 56. Waste milk was collected twice a week from one farm then sampled, cooled, and pasteurized before each feeding. Calves fed PWM and WMS avg. 0.85 kg/d gain vs. 0.72 kg/d for calves fed CON and MRS ($P < 0.05$) for the 56 d study. Hip height gain avg.13 cm for PWM and WMS vs.11 cm for CON and MRS ($P < 0.05$). There were no differences in intake of milk solids, avg. 29.7 kg for 49 d. Intake of CS, d 1 to 56, was highest for WMS (48.2 kg) with CON and PWM being intermediate (avg. 38.2 kg) and MRS the lowest (31.9 kg; $P < 0.05$). Gain/feed was highest ($P < 0.05$) for PWM (0.69 kg) with MRS (0.65 kg) being intermediate and CON and WMS the lowest ($P < 0.05$; avg. 0.64 kg).There were no differences in daily fecal scores across treatments. Days with fecal scores = 4 and health costs were higher ($P < 0.05$) for MRS vs. CON, PWM and WMS. From d 57 to d 84 there were no differences in ADG across treatments. Under conditions of this study calves fed WMS had greater CS intake than CON, MRS and PWM. Calves fed MRS did not enhance performance over CON.

T451 - Pre- and Post weaning performance and health of dairy calves fed all-milk protein milk replacers or partially replacing milk protein with plasma, and plant proteins in varying combinations. and soy protein concentrate.

One-hundred five (2-5 d old) individually fed Holstein heifer calves (39.8 ± 0.73kg) were randomly assigned to 1 of 4 treatments to evaluate pre- (d 1-42) and post weaning (d 43-56) calf performance and health when fed milk replacers (MR) with alternative protein sources. Calves were assigned to non-medicated MR with 1) All milk protein (AM), 2) 50% of total protein from wheat and plasma (WPL), 3) 50% of total protein from soybean protein concentrate (SPC) and plasma (SPL), and 4) 50% combination of wheat, SPC and plasma (SWP). All calves were fed a non- medicated 20% fat:20% CP MR at 0.284 kg in 1.99 L water (12.5% solids) 2X daily for the first 35 d and 1X daily d 36 to weaning at 42 d. Day 1 to 14, 1:1 neomycin:oxytetracycline was added to the MR solution to provide 22 mg/kg BW/d. Calf starter (CS; 18% CP) and water were fed free choice from d1. Osmolality of the MR were 469, 421, 395 and 412 mOsm/L for AM, WPL, SPL, and SWP, respectively. There were no pre- or post weaning ADG differences ($P > 0.05$). Calves averaged 0.74 kg/d gain for the 56-d study. There were no differences ($P > 0.05$) in CS or total DMI intake which averaged 55.3 and 77.08 kg for the 56-d study, respectively. Pre-weaning gain/feed was higher ($P < 0.05$) in calves fed WPL vs. those fed SPL and SWP but similar to AM calves. There were no overall 56-d differences in gain/feed ($P > 0.05$). Across treatments, calves doubled their initial BW and gained > 10.2 cm in frame growth. Fecal scores d 1 to 14 and overall were higher ($P < 0.05$) for AM fed calves compared to WPL, SPL, and SWP treatments. The number of scouring d pre-weaning were also higher ($P < 0.05$) for AM calves vs. those

fed SPL and SWP with WPL calves being intermediate. There were no differences in health treatment costs. Under the conditions of this study, replacing 50% of the total milk protein in MR with alternative sources resulted in calf performance and health similar to all milk protein.

64 - Evaluation of forage quality of five grains for use in sprouted fodder production systems for organic dairy cattle.

The objective of the study was to evaluate 5 grains for use in sprouted fodder productions systems at the University of Minnesota's West Central Research and Outreach Center, Morris, MN. Forage mass, mold score, dry matter, and forage quality were evaluated for varieties of sprouted organic barley, oats, wheat, rye, and triticale harvested at 7 d after the start of sprouting. During September 2014, on every Monday for 6 weeks, 28 fodder trays (0.6 m x 1.8 m) from a FarmTek Fodder Pro system were filled with 4.1 kg of pre-soaked grain, which was soaked for 24 h. Each tray was automatically watered 3 times a day for 4 min each time. On the seventh day, each tray was harvested, weighed, and visually scored on a 1 to 5 scale for mold by one observer. Ten random samples from each sprouted grain each week were saved for dry matter and forage quality analysis. Sprouted forage samples were sent to Rock River Laboratory, Inc., Watertown, Wisconsin, and were analyzed by wet chemistry for DM, CP, NDF, and TDN. Data were analyzed using the MIXED procedure of SAS. Independent variables for analyses were the fixed effects sprouted grain, and date of harvest and replicate were random effects. Sprouted barley (9.3 kg), oats (9.0 kg), and wheat (8.8 kg) had greater ($P < 0.05$) forage mass per tray than sprouted rye (7.8 kg) and triticale (6.3 kg). Mold scores were lower ($P < 0.05$) for sprouted barley (0.04) and oats (0.03) compared with sprouted rye (2.8) and triticale (4.8). Sprouted barley DM (15.4%) was lower ($P < 0.05$) than sprouted oat (19.1%), rye (19.8%), triticale (24.2%), and wheat (18.9%) DM. Concentrations of CP averaged 15.6%, 13.1%, 12.8%, 17.0%, and 17.9% for sprouted barley, oats, rye, triticale, and wheat, respectively, and they were different ($P < 0.05$) from each other. The NDF was greater ($P < 0.05$) for sprouted barley and oats (34.4% and 44.8%, respectively) compared with sprouted rye, triticale, and wheat (23.6%, 20.4%, and 26.7%, respectively). Sprouted triticale (79.7%) had higher TDN than sprouted oats (71.8%), which was the lowest for TDN. In summary, the results show that sprouted barley has the highest forage quality for fodder production systems.

693 - Housing and management practices on farms using automated calf feeders in the Midwestern United States.

Automated calf feeding systems are growing in popularity across the United States, yet information regarding feeder use and management is limited. This ongoing study is investigating housing and management practices on dairy farms with automated feeders. Thirty-eight Midwestern dairy farms were visited approximately every 60 d for 18 mo. Management practices data were collected using a questionnaire and calves (n = 10,185) and facilities were observed by research personnel. Of 38 calf feeding facilities, 39% were specifically constructed to house automated feeders and 61% were retrofitted; 53% were naturally ventilated barns, 39% were mechanically ventilated, and 8% were within a tunnel ventilated barn. A great majority of facilities (84%) supplemented ventilation systems with positive pressure tubes. Mean (±SD) pen size available to calves was 72.1 (±33.0) m2. Farms housed 17.6 (±7.8; range 2–63) calves per pen, allowing for 4.6 (±2.9; range 1.2–32.3) m2 of space/calf and 16.7 (±6.6; range 2–38) calves per nipple station. Calves were introduced into group pens at 5.2 (±4.0; range 0–14) days of age. A total of 68% of farms fed calves reconstituted milk replacer, 24% whole milk plus replacer or protein balancer, and 8% unsupplemented whole milk. A medicated milk product was used by 76% of farms. Milk (or replacer) allowance per day at feeder introduction was 5.4 (±2.1; range 3–15) L rising to 8.3 (±2.0; range 5–15) L at its peak. Time from feeder introduction to peak milk allowance was 18.0 (±11.4; range 0–44) days. Weaning for calves on automated feeders started at 44.5 (±6.9; range 32–60) days of age and calves were fully weaned by 56.8 (±9.0; range 40–86) days. Management of automated feeding systems was highly varied among farms in this study and an investigation of the relationship between management factors and calf morbidity and mortality will provide an understanding of factors associated with improved calf performance and welfare. This project is supported by Agriculture and Food Research Initiative competitive grant no. 2012–67021–19280 from the USDA National Institute of Food and Agriculture.

696 - Risk factors for abnormal calf health scores on farms using automated feeders in the Midwest USA.

Automated calf feeding systems are growing in popularity across the United States, yet research identifying risk factors that influence calf health is limited. This ongoing study is investigating associations between farm management, environment and housing with calf health outcomes. Thirty-eight Midwestern dairy farms were visited approximately every 60 d for 18 mo. During each visit calves (n = 10,185) were scored by a single observer for health outcomes including attitude, secretions of the ears, eyes and nose, and cleanliness of the rear end as evidence of diarrhea (0 = normal, clean calf – 58.1% of the scores; 1 = moderate coverage of loose feces – 32.4%; 2 = significant coverage of watery fecal material – 9.4%). Risk factors for higher cleanliness score (diarrhea) were assessed using multilevel ordinal logistic regression. Variables in the analysis included pen size, group size and stocking density, farm's colostrum management, and milk diet type, amount, formulation, and bacterial count. Non-significant variables were removed using backward elimination. Variable retention was set at $P < 0.05$. The association between season and cleanliness score was found to be highly significant. Odds ratios indicated that winter 2012–13 (0.78), spring 2013 (0.43), summer 2013 (0.54), fall 2013 (0.72), and spring 2014 (0.47) were all associated with reduced likelihood of diarrhea compared with winter 2013–14. Each liter increase in peak milk allowance was associated with an 11.6% decrease in odds of higher score or diarrhea (OR 0.88, *P* =

0.001). The number of days taken to reach peak milk allowance was also associated with higher score (OR = 1.02, *P* = 0.006). Increasing number of calves per group was associated with a small decrease in score or less diarrhea (OR = 0.99, *P* = 0.04). The magnitude of association observed for greater peak milk allowance suggests that feeding calves on a higher plane of nutrition, and reaching that plane earlier, may be beneficial in reducing observed diarrhea. This project is supported by Agriculture and Food Research Initiative competitive grant no. 2012-67021-19280 from the USDA National Institute of Food and Agriculture.

D. Publications

Bjorklund, E.A., B.J. Heins, A. DiCostanzo, and H.Chester-Jones. 2014. Growth, carcass characteristics, and profitability of organic versus conventional dairy-beef steers. J. Dairy Sci.97:1817-1827.

Bjorklund, E.A., B.J. Heins, A. DiCostanzo, and H.Chester-Jones. 2014.Fatty acid profiles, meat quality and sensory attributes of organic versus conventional dairy-beef steers. J. Dairy Sci.97:1828-1834.

Mousa, M.S.M., A. J. Seykora, H. Chester-Jones, D. M. Ziegler, and J. B. Cole. 2015. Heritability estimates of performance and health traits of Holstein calves. J. Dairy Sci. 98:4401-4413.

Heins, B. J., and H. Chester-Jones. 2015. Effect of feeding kelp on growth and profitability of group-fed calves in an organic production system. Prof. Anim. Sci. 31:368-374.

Starcevich, J., R.D. Moon, H. Chester-Jones, and D. Ziegler. 2015. Filth fly production and parasitism in heifer rearing pens bedded with straw, hardwood sawdust and pine shavings. Entomology Society of America, Annual Meeting, Minneapolis, MN, November 15 to 18.

Kienitz, M-A, Heins, B. J., and H. Chester-Jones. 2015. Growth and behavior of group-fed dairy calves fed once or twice daily in an organic production system. J. Dairy Sci. 98(Suppl.2):109. Abstract M285.

Maynou, G., D. Ziegler, H. Chester-Jones, A. Bach, and M. Terre. 2015. Effect of feeding calves waste milk on antibiotic resistance patterns of fecal Escherichia coli. J. Dairy Sci. 98(Suppl.2):106. Abstract M268.

Ziegler, B., D. Ziegler, H. Chester-Jones, D. Scimek, and, S. Schuling. 2015. Pre- and postweaning performance of nursery calves offered texturized calf starters with varying protein levels for 56 days. J. Dairy Sci. 98(Suppl.2):148. Abstract M398.

Ziegler, D., H. Chester-Jones, D. Cook and, J. Olson. 2015. Pre- and postweaning performance and health of dairy calves fed milk replacers vs. pasteurized waste milk. J. Dairy Sci. 98(Suppl.2):148. Abstract M399.

Heins, B.J., J.C. Paulson and, H. Chester-Jones. 2015. Evaluation of forage quality of five grains for use in sprouted fodder production systems for organic dairy cattle. J. Dairy Sci. 98(Suppl.2):206. Abstract 64.

Chester-Jones, H., D. Dean, D. Ziegler, and, K. Halpin. 2015. Pre- and post weaning performance and health of dairy calves fed milk replacers with plant and milk protein by-product sources balanced for selected amino acids. J. Dairy Sci. 98(Suppl.2):471. Abstract T449.

Ziegler, B., D. Ziegler. H. Chester-Jones, D. Schimek, M. Raeth, and D. Cook. 2015. Pre- and post-weaning performance and health of dairy calves fed all-milk protein milk replacers or partially replacing milk protein with plasma and plant proteins in varying combinations. ., J. Dairy Sci. 98(Suppl.2):471. Abstract T451.

Jorgensen, M. A.A. Progar, K. Janni, H. Chester-Jones, J. Salfer, and, M. Endres. 2015. Housing and management practices on farms using automated calf feeders in the Midwestern United States. J. Dairy Sci. 98(Suppl.2):818. Abstract 693.

Jorgensen, M. A.A. Progar, S. Godden, H. Chester-Jones , A.M. de Passille, J. Rushen, and, M. Endres. 2015. Risk factors for abnormal calf health scores on farms using automated feeders in the Midwest USA. J. Dairy Sci. 98(Suppl.2):819. Abstract 696.

Thornsberry, M., S. Younker, D. Ziegler, H. Chester-Jones, and, J. Linn. 2015. Pre- and post-weaning performance of dairy calves fed a milk-wheat-plasma protein milk replacer. J. Dairy Sci. 98(Suppl.2):758. Abstract W395.

E. IMPACT STATEMENT: The use of commercial dairy calves for nutritional and management studies up to 6 months of age and the ability to follow these calves back to their respective dairy herds for first lactation performance provides a critical base towards attaining objective 1 of the NC-1042 project. In terms of application of the results to the field, benchmarks have been developed for calf performance parameters that have been used for on-farm comparisons. Goals for calf performance in the nursery have been attained by both conventional, moderate intensive or intensive programs. Optimum calf starter intake compliments changes in liquid feeding programs to ensure calves meet their goals. Good quality calves and health management have been important keys to success. Post weaning programs have maintained calf performance which has exceeded initial expectations. The 3 cooperating dairy producers who have supported this effort have helped to improve the programs for their heifer calves from 2 to 5 days up to 6 months of age which is a critical phase for growing dairy heifers. Detailed records for each calf that arrives at SROC has helped both the dairy managers and SROC management. The unique partnership between the University of Minnesota, the commercial

dairy producers and allied industry collaborators has allowed many options to be considered for calf raising operations.

F. LEVERAGE: The current work with SROC**,** allied industry and commercial dairy partnership has leveraged interest from non-partner collaborators to maintain the level of support needed to keep the project viable.

NC 2042: 2015 Kentucky Station Report

A. PROJECT NAME: Management Systems to Improve the Economic and Environmental Sustainability of Dairy Enterprises

B. COOPERATING AGENCY and personnel:

1. Station Reporting: Kentucky
2. Personnel reporting from experiment station: Jeffrey M. Bewley

C. WORK PROGRESS AND PRINCIPAL ACCOMPLISHMENTS:

D. USEFULNESS OF FINDINGS:

This research provides new insight into the use of precision dairy technologies, the examination of sleep in cows, the lack of effect of tail docking, and the potential for compost bedded pack barns.
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E. PUBLICATIONS:

Peer-reviewed:

1. Dolecheck, K.A., W.J. Silvia, G. Heersche, Jr., C.L. Wood, K.J. McQuerry, and J.M. Bewley. 2016. A comparison of timed artificial insemination and automated activity monitoring with hormone intervention in three commercial dairy herds. J Dairy Sci. 99(2):1506-14.
2. Dolecheck, K.A., W.J. Silvia, G. Heersche, Jr., Y.M. Chang, D.L. Ray, A.E. Stone, B.A. Wadsworth, and **J.M. Bewley**. 2015. Behavioral and physiological changes around estrus events identified using multiple automated monitoring technologies. J. Dairy Sci. 98:8723–8731
3. Borchers, M. R. and J. M. Bewley. 2015. An assessment of producer precision dairy farming technology use, prepurchase considerations, and usefulness. J. Dairy Sci. 98(6):4198-4205.

Non-peer reviewed (e.g., proceedings articles, abstracts, articles for client and lay audiences:

1. Dolecheck, K.A. and **J.M. Bewley**. A new model for estimating the cost of days open. 2015 Abstract T207. American Dairy Science Association Annual Meeting. Orlando, Florida.

2. Borchers, M., B. Wadsworth, I.C. Tsai, and **J.M. Bewley**. 2015. An evaluation of precision dairy farming technologies monitoring rumination, feeding, and lying behaviors. Research poster presented in the ADSA MS Original Research Poster Competition, Orlando, Florida.

3. Nolan, D.T., **J.M. Bewley**. 2015. The effect of somatic cell score on milk yield of dairy cattle in the southeastern United States. Abstract 93. Dairy Science Association Annual Meeting. Orlando, FL. (Oral)

4. Kawonga, B.S. and **J.M. Bewley**, 2015. A cow cooling investment decision support tool for dairy farms in low and high humidity regions. Abstract No. 813. American Dairy Science Association and American Society of Animal Science Joint Annual Meeting, July 12-16. Orlando Florida.

5. Weatherly M.E., A.M. Gehman, A.M. Lisembee, J.D. Clark, L.L. Ball, and **J.M. Bewley**. 2015. Ruminal and production effects of supplementing high and low forage dairy rations with a live yeast culture. Abstract M379. American Dairy Science Association Annual Meeting. Orlando, Fl.

6. Eckelkamp, E.A., J.L. Taraba, R.J. Harmon, K.A. Akers, and **J.M. Bewley**. 2015. Comparison of mastitis, its indicators, and lameness in compost bedded pack and sand freestall farms. European Federation of Animal Science Annual Meeting. Warsaw, Poland.

7. **Bewley, J.M.,** R.A. Black, F.A. Damasceno, E.A. Eckelkamp, G.B. Day, and J.L. Taraba. 2015. Compost bedded pack barns as a lactating cow housing system. European Federation of Animal Science Annual Meeting. Warsaw, Poland.

8. Eckelkamp, E.A., J.L. Taraba, R.J. Harmon, K.A. Akers, and **J.M. Bewley**. 2015. Moisture, temperature, cow health, and bedding bacteria relationships in compost bedded pack barns. Abstract 275. American Dairy Science Association Annual Meeting. Orlando, FL.

9. Eckelkamp, E.A., J.L. Taraba, R.J. Harmon, K.A. Akers, and **J.M. Bewley**. 2015. Effect of compost bedded pack and sand bedded freestall housing on reported clinical mastitis incidence, mastitis infection prevalence, herd somatic cell count, and bulk tank somatic cell count. Abstract 4. National Mastitis Council 54th Annual Meeting Technology Transfer Session. Memphis, TN.

10. B.A. Wadsworth, L.M. Mayo, N.I. Tsai, A.E. Stone, D.L. Ray, J.D. Clark, and **J.M. Bewley**. 2015. Comparison of lying times, milk yield, rumination times, and eating times of lame versus sound cattle using Precision Technologies. Abstract 61. 10th International Conference on Lameness in Ruminants. Valdivia, Chile.

F. IMPACT STATEMENT *(in lay language for government agencies and elected representatives)*

Technology research provides new insight into the utility of automated temperature monitoring. Decision support tools will help dairy farmers understand decision economics and make more informed decisions toward improved profitability.

G. Leverage (*dollars and other resources – because of your work in this project you've been able to leverage resources from what other sources, amounts?***):** *Enter your info*

NC 2042: 2014-2015 Station Report

A. Project Name: Management Systems to Improve the Economic and Environmental Sustainability of Dairy Enterprises.

B. Cooperating Agency: New Hampshire Agricultural Experiment Station, Durham.
Personnel: P.S. Erickson, Department of Biological Sciences.
Objective 1) Optimize calf and heifer performance through increased understanding of feeding strategies, management systems, well-being, productivity and environmental impact for productivity and profitability.

C. Work progress and principal accomplishments

Under Objective 1:

1) Niacin Supplementation to Prepartum Dairy Cows: Effects Postpartum. *K.M. Aragona, and P.S. Erickson.* The objectives of this experiment were to determine the effects of nicotinic acid supplementation to prepartum dairy cows. Cows received 48 g/d for 4 wk prepartum. Results indicated that cows fed the niacin produced higher quality colostrum. In preparation for submission to the J. Dairy Sci.

2) Evaluating nitrogen efficiency, growth and body composition of calves fed either conventional, intermediate or accelerated feeding regimens. *C.E. Chapman, and P.S. Erickson.* The objectives of this study were to evaluate the growth, intake, nutrient digestibility, N efficiency, and body composition (using deuterium oxide). Twenty-four heifer calves on day 1 of life were randomly assigned within block to 1of 3 treatments. Calves were fed milk replacer twice daily, Feed and water intake were measured daily. Urine was sampled for 3 consecutive days during week 2 to 3 for creatinine determination. During the fifth week, all calves had urinary catheters inserted (urine collected for 3 d) and received 2 g/d Chromium oxide as a digestibility marker. Feces, urine and orts were collected for determination of nutrient digestibility and N retention. Calves were fed milk replacer 1X/d on d 43-49 and then weaned on d 50. On d 50, calves will be dosed with salinized deuterium oxide (300 mg/kg) and blood samples removed 1 h later and daily for the next 6 d. Calves end the experiment on d 56. In preparation for submission to J. Dairy Sci.

3) Utilization of Nuclear Magnetic Resonance for determination of deuterium oxide in calf blood plasma. *C.E. Chapman and P.S. Erickson.* Deuterium oxide can be used as a marker for determination of body composition. A method was developed which is highly repeatable that utilizes plasma analyzed using a specific deuterium magnet. The results will be submitted to J. Dairy Sci. as a technical note.

4) Determination of cinnamaldehyde taste preference. *C.E. Chapman and P.S. Erickson.* Six three month old heifer calves were provided with either 0, 1, 2,3, or 4 mg/kg

cinnamaldehyde and allowed to choose which they preferred. Results indicated that calves prefer cinnamaldehyde in the following order 0, 2, 1, 3, 1nd 4 mg/kg. The results are in preparation for submission to the J. Dairy Sci.

5) Effects of cinnamaldehyde supplementation to post-weaned dairy heifers. *C.E. Chapman, P.S. Erickson, H.Chester-Jones, D. Ziegler*. Eighty-four post-weaned dairy heifers were fed in pens either 0, 1 mg/kg monensin, 1 mg/kg cinnamaldehyde or 2 mg/kg cinnamaldehyde. Weekly body weights and withers heights were determined along with daily pen intakes. Fecal samples from 4 calves/pen were taken weekly for coccidian oocyst counts. Weekly blood samples were taken for determination of growth hormone and glucose. Blood sample analyses and statistical analyses are underway

D. **Usefulness of findings:**

Experiment 1) Cows fed 48 g/d nicotinic acid for 4 wk prepartum produced higher quality colostrum based on IgG concentration (86 g/L vs. 73 g/L respectively). Farmers can enhance colostrum quality by feeding 48 g/d nicotinic acid for 4 wk prepartum.

Experiment 2) Calves fed the higher protein milk replacer grew at a faster rate but were less efficient in utilizing dietary N.

Experiment 3) Nuclear magnetic resonance is an easy way of determining body composition by specifically measuring deuterium in plasma of calves injected with a dose of deuterium oxide.

Experiment 4) Calves prefer no cinnamaldehyde compared to any cinnamaldehyde. This allowed us to determine what concentration of cinnamaldehyde calves would consume.

Experiment 5) Research and statistical analysis are underway.

E. Publications:

Peer-reviewed

1. Cabral, R.G., C.E. Chapman, K.M. Aragona, E. Clark, M. Lunak and P.S.Erickson.2015. Predicting colostrum quality from performance in the previous lactation and environmental changes. J. Dairy Sci. (submitted).

2. Cabral, R.G., C.E. Chapman, E.J. Kent, and P.S. Erickson. 2015. Estimating plasma volume in neonatal Holstein calves fed one or two feedings of a lacteal-based colostrum replacer using Evans blue dye and hematocrit values at various time points. Can. J. Anim. Sci. 95:293-298.

3. Connelly, R.A. and P.S. Erickson. 2015. Lactoferrin supplementation of the neonatal calf has no impact on immunoglobulin G absorption and intestinal development in the first days of life. J. Anim. Sci. (submitted).

4. Guindon, N.E., N.T. Antaya, R.G. Cabral, N.L. Whitehouse, T.J. Earleywine and P.S. Erickson. 2015. Effects of human visitation on calf growth and performance of calves fed different milk replacer feeding levels. J. Dairy Sci. 93: In press.

Abstracts:

1) Aragona, K.M., C.E. Chapman, A.B.D. Pereira, and P.S. Erickson. 2015. Prepartum supplementation of niacin increases colostral immunoglobulin G content in dairy cows. J. Dairy Sci. 93 (Suppl.2):53.

2) C.E. Chapman, T.M. Hill, and P.S. Erickson. 2015. Nitrogen utilization and growth effects in Holstein dairy calves fed a moderately high protein or conventional milk replacer. J. Dairy Sci. 93 (Suppl.2): 384-385.

3) A. Mendes, M.R. Murphy, P.S. Erickson, and D.P. Casper. 2015. The sex ratio of female to male calves may be affected by number of services to achieve conception and lactation number of the lactating dairy cow. J. Dairy Sci. 93 (Suppl. 2): 109.

Non-Peer Reviewed: all published in the UNH Dairy Report Summer 2015

1) Cabral, R.G., M.A. Cabral, C.E. Chapman, E.J. Kent, D.M. haines, and P.S. Erickson. Colostrum replacer feeding regimen, addition of sodium bicarbonate, and milk replacer: The combined effects on absorptive efficiency of immunoglobulin in neonatal calves.7-9.

2) Chapman, C.E., and P.S. Erickson. Nitrogen retention and nutrient partitioning in Holstein dairy calves fed high-protein or conventional milk replacer. 10-13.

3) Guindon, N.E., N.T. Antaya, and P.S. Erickson. Effects of human visitation on calf performance.14-17.

4) Standish, R.B. and P.S. Erickson. Effects of supplementing niacin to close up dry cows on milk production and components, transition cow disease, and serum metabolites postpartum. 23-28.

F. M.S. Thesis: Prepartum Supplementation of Nicotinic Acid: Effects on Health of the Dam, Colostrum Quality and Acquisition of Immunity in the Calf. K.M. Aragona

G. Ph.D. Dissertations – none.

H. Leverage-

1) $15,000 Cinnamaldehyde in growing heifers - George Walker Milk Fund (Chapman, Ph.D. project)

2) $32,410 Probiotics for pre and postpartum dairy cows- Agri-King, Inc. (Ort, MS project)

3) $70,000 Niacin and β-carotene for prepartum cows: Effects on colostrum and calf performance- DSM (Aragona, Ph.D. project)

4) $37,410 Na-butyrate for post-weaned heifers- Nutriad (Rice, MS project)

I. Grants Outstanding

$39,000 for evaluating protected niacin impact on epinephrine stimulated lipolysis-Balchem (Aragona, Ph.D. project)

J. **Grants In Progress: none**

NC 1042: 2015 Station Report

A. PROJECT NAME: Management Systems to Improve the Economic and Environmental Sustainability of Dairy Enterprises (Rev. NC 1119).

B. COOPERATING AGENCY: Maryland Agricultural Experiment Station, College Park.

Personnel: K.M. Moyes[1], Dale M. Johnson[2], Stanley W. Fultz[2], and R. R. Peters[1].
Department of Animal and Avian Sciences[1] and University of Maryland Extension[2] .

Project Objectives addressed in Maryland:

Main objective: *Provide for collaborative research leading to dairy management strategies and systems to facilitate sustainable and profitable decisions by managers of milking cow and heifer enterprises.* **Objective 3:** Analyze whole farm system components and integrate information into decision-support tools to improve efficiency, enhance profitability, and environmental sustainability. **Sub-objective C.,** Precision Dairy

C. WORK PROGRESS AND PRINCIPAL ACCOMPLISHMENTS:
Under Sub-objective 3C:

As herd size continues to increase globally, new technology allowing farmers to remain sustainable is greatly desired. Automatic milking systems (AMS) represent the most recent technology available by offering improved management and production efficiency, quality of life and attractiveness to successors to dairy farmers. Results from a survey we recently sent to dairy farmers in the Mid-Atlantic region reported that more information on animal health/productivity and economic impact would be helpful when considering a transition to AMS. The objectives of this study are to 1) summarize, interpret and publish results from the survey and 2) use case study farms to estimate and quantify the economic impacts and animal health/productivity and lifestyle changes for small-to medium sized dairy farms regarding the transition from conventional to AMS in the Mid-Atlantic region. Results will serve as the foundation for larger grants (i.e. USDA AFRI- Food Security) for implementation into decision-support tools that will estimate and quantify economic impacts, performance outcomes and lifestyle changes associated with AMS for dairy farms in the Mid-Atlantic region. In turn, the information provided will help farmers determine whether AMS is economical and personally beneficial for their farm thereby helping sustain the dairy industry in the Mid-Atlantic region.

D. USEFULNESS OF FINDINGS:

The high cost of land, low profits, and labor availability are the primary reasons for lack of expansion of small to medium-sized (i.e. 30-200 milking cows) in the Northeastern (NE) United States. . As herd size continues to increase globally, new technology that allows NE farmers to remain sustainable is greatly desired. Automatic milking systems (AMS) represent the most recent technology available by offering improved management and production efficiency, quality of life and attractiveness to potential successors. However, the financial investment is

substantial ($minimum of $200,000 to 500,000) and farmers lack decision-making tools regarding the challenges and opportunities associated with the transition from conventional to AMS. This research will help to identify the management, financial, and lifestyle adjustments that producers will need to be aware of for using AMS technology. Results will also serve as the basis for education programs designed to provide farmers with the decision-making tools required to estimate and quantify economic impacts, performance outcomes and lifestyle changes associated with AMS.

E. PUBLICATIONS:

Peer reviewed (e.g., proceedings articles, abstracts, articles for client and lay audiences:

None

F. IMPACT STATEMENT *(in lay language for government agencies and elected representatives)*

Four dairy farms in New York are currently participating in this two-year case study research project. Initial survey work has been completed to enroll the producer participants and a one year follow-up survey has been completed. No data have been summarized.

G. Leverage (*dollars and other resources – because of your work in this project you've been able to leverage resources from what other sources, amounts?*): 1) $30,500 Integrated Maryland Agricultural and Experiment Station and University of Maryland Extension Competitive Grant Program. Title of Grant Proposal: Estimating and quantifying the economic impacts, production outcomes and lifestyle changes for small-to medium sized dairy farms regarding the transition from conventional to Automatic Milking Systems in the Mid-Atlantic region.

NC-2042: 2013-2014 Station Report – Virginia Tech

Project Name: Management Systems to Improve the Economic and Environmental Sustainability of Dairy Enterprises.

Objectives

The objectives of this project are:

1. Improve dairy cow management decisions through nutrient utilization, well-being and profitability
2. Analyze whole farm system components and integrate information into decision-support tools to improve efficiency, enhance profitability, and environmental sustainability.

Time period: 10/01/2014 to 9/30/2015

Outputs

We evaluated the potential interaction of biotin with pantothenic acid on lactation performance of lactating dairy cows. Contrary to our hypothesis, pantothenic acid did not affect the lactating performance, and neither the absorption of biotin.

We evaluated the use of remote sensing techniques to predict the variation of forage quality from the field. For this experiment vegetation index maps from three areas in Virginia (specifically Montgomery, Pittsylvania and Washington Counties) were developed. Whole-plant corn samples were harvested and analyzed for their nutritional quality. Contrary to our expectations, the nutritional composition of corn plants did not differ in cornfields.

We evaluated the effect of plant density of corn on dry matter yield and nutritional quality of corn whole-plant for silage. For this, corn plots were planted at four different densities in a commercial farm. The preceding crop was ryegrass for silage. The nutritional quality of plants harvested in different environments was not affected by planting density.

We developed an educational video in Spanish with scripts in English about calf management. This video intends to educate the Hispanic labor force in dairy farms, as well as diminishing the communication barrier between English-speaking employers and Spanish-speaking employees.

We delivered 2 educational workshops about risk management and the Margin Protection Program for dairy.

Publications

1. Ferreira, G. 2014. Drought Stress and Corn Silage Quality: Is It Just a Matter of Rainfalls? (Pp. 109-111). Proceedings from the Penn State Dairy Nutrition Workshop, Grantville, PA, November 12-13, 2014.
2. Cayford, E. L., L. Feng, S. Yang, and G. Ferreira. 2015. Use of green vegetative

3. Ferreira, G. 2015. Environment and crop management as determinants of forage yield and quality in the Southeast. J. Dairy Sci. (Abstract).
4. Ferreira, G., P. Hammock, M. Hammock, I. Hammock, and N. Hammock. 2015. Effect of corn planting density on yield and nutritional quality of corn silage when planted after ryegrass harvested for silage. J. Dairy Sci. (Abstract).
5. Ferreira, G., A. N. Brown, and C. L. Teets. 2015. Effect of biotin and pantothenic acid supplementation on performance and concentration of avidin-binding substances (ABS) in lactating dairy cows. J. Dairy Sci. (Abstract).
6. Ferreira, G. 2015. Management Strategies to Endure Adverse Scenarios. Proceedings from the 2015 Area Dairy Conference, March 9-13, 2015.
7. Ferreira, G. 2015. Should winter crops be considered cover crops in dairy farming systems? VT Dairy Pipeline Vol. 36, No. 2. Virginia Cooperative Extension, DASC-47NP.
8. Ferreira, G. 2015. Understanding the Effects of Drought Stress on Corn Silage Yield and Quality (Pp. 91-99). Proceedings from the 2015 Tri-State Dairy Nutrition and Management Conference, Fort Wayne, IN, April 20-22, 2015.
9. Bladen, A. N., and Ferreira, G. 2015. Educational video: Manejo del becerro recién nacido / Newborn calf management. Virginia Cooperative Extension, DASC-49P.
10. Ferreira, G. 2015. Income Over Feed Costs in the Dairy Enterprise. Virginia Cooperative Extension, DASC-51P.
11. Ferreira, G., A. N. Brown, and C. L. Teets. 2015. Effect of biotin and pantothenic acid on performance and concentrations of avidin-binding substances (ABS) in blood and milk of lactating dairy cows. J. Dairy Sci. 98:6449–6454.
12. Ferreira, G. 2015. Purchased forages: How do we decide what to buy? Proceedings from the 2015 Virginia State Feed Association and Nutritional Management Cow College Conference, Roanoke, VA, February 18-20, 2015.

Participants

Dr. Gonzalo Ferreira is principal investigator (PI) responsible for presenting the workshops, and designing and conducting the experiments. He also supervises undergraduate and graduate students. Undergraduate and graduate students are responsible for collecting, processing and analyzing samples. Mrs. Christy Teets is a laboratory specialist in the dairy nutrition lab, who is in charge of supervising students while analyzing samples. The PI is also collaborating with multiple dairy farmers within the State of Virginia (specifically, dairy farmers from Franklin, Montgomery, Pittsylvania, Rockingham, and Washington counties).

Target Audience

The target audiences are dairy farmers in general, extension agents, consultants, and government agents (i.e, NRCS, FSA, DCR, etc).

NC 2042: 10/01/2014-09/31/2015 Pennsylvania State University Station Report

A. PROJECT NAME: **Management Systems to Improve the Economic and Environmental Sustainability of Dairy Enterprises**

B. COOPERATING AGENCY and personnel: Penn State University A. J. Heinrichs, L. A. Holden, R. A. White, , C. A. Jones, , S. L. Gelsinger, F. H. Pino, J. A. Suarez- Mena, A. D. Kmicikewycz.

Project Objectives

Main objective: To evaluate and develop sustainable management systems for dairy herds that address critical quality and variance control factors with implications to economic efficiencies and environmental impacts.

1) To analyze management and nutrition strategies for replacement heifers as they pertain to production and profitability (heifers)

2) To optimize lactating and dry cow decision-making as it relates to animal health, nutrient utilization, milk production, reproduction, and profitability (cows)

3) To evaluate system components and integration of information into decision-support tools and whole farm analyses to improve efficiency, control variation, and enhance profitability, and environmental sustainability (whole farm)

C. WORK PROGRESS AND PRINCIPAL ACCOMPLISHMENTS

Under Objective 1 of Project:

Eight rumen cannulated dairy heifers (15.4 ± 0.8 month of age and 438.31 ± 18.08 kg of BW) were fed a high forage diet with four different levels of starch (3.5, 12.9, 22.3 and 31.7 %) and two types of trace minerals (TM; organic and inorganic; OTM and ITM). Trace minerals did not show differences in digestibility parameters, but the level of starch showed a tendency to affect DM digestibility (P = 0.08). pH was lower for diets with OTM (P = 0.01) which is related to the higher total VFA production and butyrate proportion (P = 0.03). These variables can be explained by the higher bioavailability of the OTM and faster utilization and fermentation by rumin microorganisms. The ITM stimulates water consumption resulting in a higher total manure production (P <0.01). Overall, excretion of TM were not different by treatments. In addition, blood plasma showed higher concentrations for some OTM and no difference in others. These results suggest a higher absorption for this kind of TM because intake was lower for OTM (P = 0.05). In conclusion OTM showed higher absorption and bioavailability than ITM. This is reflected by changes in rumen pH and fermentation. Also ITM stimulates water consumption, which produces more total manure than OTM that could consequently affect the environment and management in a farm.

The objective of another study was to evaluate the effects limit feeding diets of different predicted energy density on the efficiency of utilization of feed and nitrogen and the rumen responses in younger and older Holstein heifers. Eight rumen cannulated Holstein heifers (4 were 10 mo: Young, 4 were 22 mo: Old) were limit-fed high (HED) or low (LED) energy density diets according to a 4 period split-plot Latin square design with 28 d periods. Diets were fed to provide isonitrogenous and isoenergetic intake on a rumen empty BW basis. Rumen pH was lower, NH_3 concentration tended to be higher,

and VFA concentration was not different for HED compared to LED but was unaffected by age group. Rumen content mass was greater for heifers fed LED and Old heifers, so when expressing rumen fermentation responses corrected for this difference in pool size, NH_3 pool size was not different between diets and total moles of VFA in the rumen were greater for heifers fed LED while these pool sizes were greater for Old heifers. Total tract digestibility of potentially digestible NDF was greater in heifers fed LED and Young heifers, while the fractional rate of ruminal passage and digestion of NDF were both greater in heifers fed LED. Digestibility of N was greater for heifers fed HED, but was unaffected by age group, whereas the efficiency of N retention was greater for heifers fed HED and Young heifers. Environmental output was reduced in heifers fed HED, but the effect was largest in Old heifers. Results confirm previous studies in which Young heifers utilize N more efficiently than Old heifers, primarily through greater efficiency of post-absorptive metabolism. Results also support the concept of limit feeding higher energy density diets as a potential means to increase the environmental efficiency of raising dairy heifers, without sacrificing rumen health or lean tissue growth.

The objective of an experiment was to compare the effects of feeding an organic program, which included proteinate forms of Fe, Zn, Mn, Cu, Co, and Se in combination with supplemental mannan oligosaccharides and products of yeast and bacterial fermentation, or an inorganic program consisting of sulfate mineral forms and no supplemental mannan oligosaccharides or fermentation products. Mineral treatments did not impact body weight, starter intake, plasma IgG, Cu or Se, fecal IgA or the frequency of scours. However, feeding the organic mineral program to pregnant cattle reduced the frequency of general health scores > 2 and plasma haptoglobin > 50 µg/mL. General health scores were also improved by feeding the organic mineral program to calves. The proportion of calves experiencing high haptoglobin and plasma concentrations of Cu, Mn, Se, and Zn varied with week of age. Feeding this organic mineral program may improve calf health and mineral bioavailability.

Objective 3-
Continued evaluation of data with dairy advisory teams indicated that maximum impact on herd performance occurred after the first year of team operation, and the areas most improved were in reproductive management and milk quality.

D. USEFULNESS OF FINDINGS:

Mineral source and other supplements fed to pregnant cattle and calves can reduce inflammation and improve overall calf health and vigor. In dairy heifers they were shown to be absorbed more efficiently.

Our study demonstrates the value of feeding clean colostrum to newborn calves. The efficiency of IgG absorption and total amount absorbed is affected by absorbed more efficiently level as well as heat treatment.

The concept of limit feeding higher energy density diets to heifers was shown as a potential means to increase the environmental efficiency of raising dairy heifers, without sacrificing rumen health or lean tissue growth.

Data from the high and low profit herd dataset resulted in strong correlation between invest through measurement of assets per cow and overall herd profit levels. Additional analysis using data envelopment analysis techniques may yield an "indicators of profit" for various economic conditions..

E. PUBLICATIONS:

Peer-reviewed/ research and extension.

Gelsinger, S. L., A. J. Heinrichs, C. M. Jones, R. J. VanSaun, D. R. Wolfgang, C. M. Burns, and H. R. Lysczek. 2014. Efficacy of on-farm use of ultraviolet light for inactivation of bacteria in milk for calves. J. Dairy Sci. 97:2990-22997.

Kmicikewycz, A. D. and A. J. Heinrichs. 2014. Feeding lactating dairy cattle long hay separate from the total mixed ration can maintain dry matter intake during incidents of low rumen pH. J. Dairy Sci. 97: 7175-7184.

Kmicikewycz, A. D. and A. J. Heinrichs. 2015. Effect of corn silage particle size and supplemental hay on rumen pH and feed preference by dairy cows fed high-starch diets. J. Dairy Sci. 98: 373-385.

Lascano, G. J., A. J. Heinrichs, and J. M. Tricarico. 2015. *Saccharomyces cerevisiae* live culture affects rapidly fermentable carbohydrates fermentation profile in precision-fed dairy heifers. Can. J. Anim. Sci. 95:117-127.

Lascano, G. J., A. J. Heinrichs, R. R. Gary, P. A. Topper, R. C. Brandt, A. Adviento-Borbe, and E. Fabian. 2015. Effects of forage-to-concentrate ratio and dietary fiber manipulation on gas emissions and olfactometry from manure of Holstein heifers. J. Dairy Sci. 98: 1928-1937.

Suarez-Mena, F. X., A. J. Heinrichs, T. M. Hill, and J. D. Quigley. 2015. Digestive development in neonatal dairy calves with either whole or ground oats in the calf starter. J. Dairy Sci. 98:3417-3431.

Gelsinger, S. L., A. M. Smith, and A. J. Heinrichs. 2015. Comparison of radial immunodiffusion and enzyme-linked immunosorbant assay for quantification of bovine IgG in colostrum and plasma. J. Dairy Sci. 98:4084-4089.

Gelsinger, S. L., and A. J. Heinrichs. 2015. Effect of heat treatment and bacterial population of colostrum on passive transfer of IgG. J. Dairy Sci. 98:4640-4645.

Kmicikewycz, A. D., K. J. Harvatine, and A. J. Heinrichs. 2015. Effects of corn silage particle size, supplemental hay, and forage to concentrate ratio on rumen pH, feed preference, and milk fat profile of dairy cattle. J. Dairy Sci. 98: 4850-4868.

Ding, L. M., G. J. Lascano, and A. J. Heinrichs. 2015. Effect of precision feeding high and low quality forage with different rumen-degradable protein levels on nutrient utilization by dairy heifers. J. Animal Sci. 93: 3066-3075.

Suarez-Mena, F. X., G. J. Lascano, D. E. Rico, and A. J. Heinrichs. 2015. Digestion and rumen fermentation in precision-fed dairy heifers on low or high forage rations at four levels of dry distillers grain. J. Dairy. Sci. 98:8054-8065.

Suarez-Mena, F. X., A. J. Heinrichs, T. M. Hill, and J. D. Quigley. 2015. Straw particle size in calf starters: Effects on digestive system development and rumen fermentation. J. Dairy Sci. 98:on-line.

Non-peer reviewed (e.g., proceedings articles, abstracts, articles for client and lay audiences:

Pino, F. and A. J. Heinrichs. 2015. Effect of Trace Minerals and Different Levels of Starch on Digestibility and Ruminal Fermentation in Diets for Dairy Heifers. J. Dairy Sci. 98 (E-Suppl.2): 308 (Abst.).

Gelsinger, S. L. 2015. *Tools to assess colostrum management.* Penn State Dairy Extension Website. http://extension.psu.edu/animals/dairy/nutrition/calves/colostrum/tools-to-assess-colostrum-management

Gelsinger, S. L. 2015. *Pick the best pasteurizer.* Vita Plus Starting Strong Calf Care E-news. February issue.

Suarez, X., J. Heinrichs, and C. Jones. 2015. Do calves need forage? Hoard's Dairyman. 160: 608-609.

F. IMPACT STATEMENT

Organic minerals are absorbed with greater efficiency than organic forms and appear to have benefits for improving calf health.

Dairy heifers can be fed in a manner that is more environmentally efficient with no adverse effects.

The ability to improve on-farm management through more frequent nutrient testing of feedstuffs and the use of dairy advisory teams, can be beneficial in increasing milk yield and enhancing animal and farm level performance.

G. Leverage

Heinrichs, A. J. 2015. High starch rations for dairy heifers. Ascus Biosciences, Inc. $50,000.

Key words – best management practices, dairy profitability, calf management, heifer nutrition, ration sorting and particle size, dairy advisory team

Annual Project Report
North Central Cooperative Research Project NC-2042
Year ending September 30, 2015

A. Project Management Systems to Improve Economic and Environmental Sustainability of Dairy Enterprises

B. Cooperating Agency: USDA-ARS, U.S. Dairy Forage Research Center, Madison, WI 53706

Personnel: K. F. Kalscheur, NC-2042 member
USDA-ARS, USDFRC, Madison, WI

Project Objectives
Main objective: To evaluate and develop sustainable management systems for dairy herds that address critical quality and variance control factors with implications to economic efficiencies and environmental impacts.

1) To analyze management and nutrition strategies for replacement heifers as they pertain to production and profitability (heifers)
2) To optimize lactating and dry cow decision-making as it relates to animal health, nutrient utilization, milk production, reproduction, and profitability (cows)
3) To evaluate system components and integration of information into decision-support tools and whole farm analyses to improve efficiency, control variation, and enhance profitability, and environmental sustainability (whole farm)

C. Work progress and principal accomplishments:

Objective 2: To optimize lactating and dry cow decision-making as it relates to animal health, nutrient utilization, milk production, reproduction, and profitability (cows).

1. **Use of canola meal in dairy cow diets with varying concentration of starch sources.** Matching of the degradability of non-structural carbohydrate and rumen degradable protein has been identified as an effective method of increasing intestinal AA flow through increased microbial protein synthesis and more efficient ruminal fermentation, thereby increasing performance of dairy cows. Therefore, the objective was to determine the performance of lactating cows fed either corn and barley starches at varying proportions in diets containing canola meal as the major source of supplemental protein. Twelve multiparous and 4 primiparous Holstein cows (94 ± 25 DIM) were used in a 4 x 4 Latin square design with 28-day periods. The ratio of starch from ground corn and rolled barley within each treatment was 100:0, 67:33, 33:67, and 0:100. Diets contained 36% corn silage, 20% alfalfa haylage, and 44% concentrate (DM basis). Varying proportions of corn and barley had no effect ($P>0.10$) on dry matter intake (26.5 kg/d) or milk production (41.2 kg/d). Milk fat percentage (3.52%) and yield (1.42 kg/d) and milk protein percentage (2.95%) and yield (1.21 kg/d) were not affected by starch. Lactose percentage (4.86, 4.83, 4.90, and 4.88%, for 100:0, 67:33, 33:67, and 0:100, respectively) and MUN (14.8, 14.5, 15.4, and 15.1 mg/dl) responded cubically ($P<0.05$) to the changes in dietary starch proportions. Treatments did not affect energy-corrected milk (40.6 kg/d) nor feed efficiency (1.53). Increasing the proportion of barley to corn had no effect on the molar proportion of ruminal acetate and butyrate, however, propionate increased quadratically as barley increased in the diets ($P<0.01$). Ruminal

ammonia concentration averaged 11.5 mg/dl and was not affected by starch source. Apparent total tract digestibilities of DM, OM, and NDF decreased linearly ($P<0.05$) and, CP and ADF tended to decrease linearly ($P<0.10$) when the proportion of barley starch increased in the diet. Total tract digestibility of starch was not affected by starch source and averaged 95.5%. Overall, lactation performance was not affected by feeding varying proportions of corn and barley when the diets were formulated with canola meal as the primary protein supplement.

2. **Effect of the starch level in diets with soybean or canola meal on the performance of lactating dairy cows.** This study was designed to test the impact of reducing corn grain starch with nonforage fiber sources in diets using either soybean meal or canola meal as the primary protein source. Sixteen Holstein cows were assigned to a 4×4 Latin square design with 4 periods of 28 d. Treatments were arranged as a 2×2 factorial with 2 protein sources [soybean meal (SBM) and canola meal (CM)] and 2 starch levels (21 and 27% of DM). Diets were formulated to contain 16.5% CP and the starch levels were achieved by replacing corn grain with soybean hulls and beet pulp. Protein source×starch interactions ($P<0.05$) were observed for DMI, feed efficiency (ECM/DMI), fat %, protein %, protein yield, and MUN. Cows fed the 27% starch diet consumed more DMI than cows fed the CM-21% diet. However, there was no interaction for milk yield, as cows fed 27% starch produced 2.5 kg/d more than cows fed 21% starch. Milk fat percentage was the least for cows fed CM-27% and greatest for cows fed SBM-27% and CM-21%. Milk protein percentage and yield was least for CM-21% compared to the other 3 diets. Milk urea nitrogen was least for cows fed CM-27% compared to the other 3 diets. Cows fed 27% starch produced 1.9 kg/d more energy-corrected milk (ECM) than cows fed 21% starch. Feed efficiency was the greatest for cows fed CM-21% and least for cows fed CM-27%. Overall, lower starch % in SBM or CM diets negatively affected DMI, milk yield, ECM, and milk protein percentage and yield, but not feed efficiency and milk fat percentage and yield. Increasing starch level in canola meal diets decreased milk fat percentage, but potentially improved protein balance because less MUN was observed.

D. Usefulness of findings:

Replacing barley with corn did not alter production performance of dairy cows in diets where canola meal was the primary protein supplement.

Reducing starch from 27% to 21% in both soybean meal and canola meal based diets decreased milk production and energy-corrected milk. Cows fed the 27% starch diets with canola meal decreased milk fat percentage, but potentially improved protein balance because less MUN was measured.

E. Publications:

Journal

Acharya, I. P., D. J. Schingoethe, K. F. Kalscheur, and D. P. Casper. 2015. Response of lactating dairy cows to dietary protein from canola meal or distillers grains on dry matter intake, milk production, milk composition, and amino acid status. Can. J. Anim. Sci. 95:267-279.

Anderson, J. L., K. F. Kalscheur, A. D. Garcia, and D. J. Schingoethe. 2015. Feeding fat from distillers dried grains with solubles to dairy heifers: I. Effects on growth performance and total tract digestibility of nutrients. J. Dairy Sci. 98:5699-5708.

Anderson, J. L., K. F. Kalscheur, J. A. Clapper, G. A. Perry, D. H. Keisler, A.D. Garcia, and D.J. Schingoethe. 2015. Feeding fat from distillers dried grains with solubles to dairy heifers: II. Effect on metabolic profile. J. Dairy Sci. 98:5709-5719.

Anderson, J. L., K. F. Kalscheur, A. D. Garcia, and D. J. Schingoethe. 2015. Short Communication: Feeding fat from distillers dried grains with solubles to dairy heifers: III. Effects on posttrial reproductive and lactation performance. J. Dairy Sci. 98:5720-5725.

Anderson, J. L., K. F. Kalscheur, A. D. Garcia, and D. J. Schingoethe, D. P. Casper, and D. H. Kleinschmit. 2015. Ensiling characteristics of distillers wet grains with corn stalks and determination of the feeding potential for dairy heifers. Prof. Anim. Sci. 31:359-367.

Abstracts

Diaz-Royon, F., A. D. Garcia, K. F. Kalscheur, and K. Mjoun. 2015. Effects of feeding slow-release NPN and microbial fermentation extracts on ruminal pH, ammonia and volatile fatty acids. J. Dairy Sci. 98 (Suppl. 2):745.

Jayasinghe, N. K., K. F. Kalscheur, J. L. Anderson, and D. P. Casper. 2015. Canola meal in dairy cow diets with varying concentration of starch sources. J. Dairy Sci. 98 (Suppl. 2):128.

Kalscheur, K. F., and A. D. Garcia. 2015. Ensiling wet distillers grains with solubles: A review. XVII International Silage Conference, Brazil, July 1 - 3. pp. 248-249.

Sanchez-Duarte, J. I., K. F. Kalscheur, and D. P. Casper. 2015. Effect of the starch level in diets with soybean or canola meal on the performance of lactating dairy cows. J. Dairy Sci. 98 (Suppl. 2):736-737.

F. Impact statement:

Research conducted at South Dakota State University and USDA-ARS demonstrated that:

- The source of carbohydrate provide in the diet, whether it is barley or corn, did not impact milk production nor milk composition of dairy cow diets formulated with canola meal as the primary protein supplement.
- Decreasing starch from 27% to 21% in the diet decreased milk production 2.5 kg/cow/day. Impact of starch level on milk composition varied depending on whether soybean meal or canola meal was the protein supplement.

G. Leverage:

Maximize the use of canola meal in dairy feeds. Canola Council of Canada. $280,000.