NC2042: MANAGEMENT SYSTEMS TO IMPROVE ECONOMIC AND ENVIRONMENTAL SUSTAINABILITY OF DAIRY ENTERPRISES.
5 Year Final Report (2013-2018)

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.

Accomplishments: Raising replacement heifers represents a significant investment for producers in time and resources. It is not until the start of lactation that any return on investment is received. Thus, it is critical to the success of the dairy industry that efficiencies be improved and advancements continued to be made in calf and heifer management. Research was conducted with newborn calves through gravid pre-fresh heifers, much of which is utilized by producers and stakeholders to improve performance of growing dairy cattle.

Short-term Outcomes: Guidelines and recommendations were delivered to farms relative to colostrum management for calves as well as improving heifer performance through alternative feeds and feed additives. Adoption of these practices contributed to reduced costs of raising replacement heifers and improved nutrient utilization, health, and well-being of dairy calves and heifers.

Outputs:

- More than 50 peer-reviewed publications on calf and heifer management and nutrition.
- More than 30 theses and dissertations produced.
- More than 40 extension articles or deliverables and more than 20 producer workshops or presentation were given.
- One patent application was submitted on a methodology to evaluate calf body composition.
- Models and programs were developed to assist stakeholders with evaluation of heifer ration formulations, growth performance, and colostrum quality.

Activities:

- Colostrum management: Research at 3 collaborating stations (NC, NH, PA) has evaluated effects of: transition cow nutrition on colostrum quality, colostrum management on calf performance, and disease transfer.
- Water quality for calves: Research at 3 stations (MI, SD, NH) evaluated effects of water quality and treatments on palatability and calf performance.
- Feed additives: Research at 5 stations (MN, MS, NH, PA, and SD) has evaluated the effects of cinnamaldehyde, condensed whey solubles, prebiotics and probiotics, sodium butyrate on growth, development, and nutrient utilization of calves and heifers.
- Alternative Ingredients: Three stations (MN, PA, SC and SD) have evaluated alternative protein sources (plasma, wheat, vegetable proteins, and soy) for calf milk replacer and starters. Effects of alternative concentrate ingredients (distillers grains, oilseed meals, hydroponic barley sprouts, urea, casein, and poultry fat) on heifer growth performance, nutrient utilization, metabolic profile and onset of puberty. Three stations (PA, SD and WI) have evaluated different forage sources (seasonal grass, corn stalks, alfalfa stems, and sorghum silages) on heifer performance and nutrient utilization.

- Feeding strategies: Work at PA, SC, and SD evaluated precision feeding versus traditional ad libitum strategies for heifers.
- Growth performance effects on lactation: Two meta-analysis (PA and MN) have evaluated pre-weaning dry matter intakes on first lactation performance.

Milestones:
- Adoption of precision feeding of dairy heifers by producers as a method to increase growth efficiency.
- Improvement of colostrum management programs on dairy farms across the US.
- Increased utilization of distillers' grains and other alternative feeds by dairy nutritionists and producers.

Impacts and Activities:
- More than 30 graduate students were trained in calf and heifer management and are now active professionals in the dairy industry.
- More than 40 extension articles or deliverables and more than 20 producer workshops or presentation were given and help to educate hundreds of producers.
- Two review articles have been generated and over that last 5 years more than 100 peer-reviewed articles have published related to Objective 1.
- Models and programs were developed to assist stakeholders with evaluation of heifer ration formulations, growth performance, and colostrum quality which are helping with better management of calves and heifers.

Milestones: ***Long-term impacts:*** Producers and the dairy industry have benefited from healthier calves and heifers. Due to improved colostrum management, enhanced feeding strategies, and alternative treatment of diseases, research from this project will result in recommendations to producers that will result in healthier calves and heifers. This research has increased economic well-being of dairy farmers. Healthy and productive heifers are critical for success of the dairy industry. Also, rearing calves and heifers is one of the largest expenses in dairy farming. Best management practices that increase production performance, reduce operative expenses, or both will ensure the economic well-being for dairy producers.

Indicators:
- More than 30 graduate students were trained in calf and heifer management and are now active professionals in the dairy industry.
- More than 40 extension articles or deliverables and more than 20 producer workshops or presentation were given and help to educate hundreds of producers.
- Review articles focused on heifer growth and development have reached national and international audiences with more than 100 views in SCOPUS.

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

Accomplishments: Overall research under objective 2 has provided, and continues to provide, producers and nutritionists ways to advance and make better decisions in the nutritional management of dairy herds.

Short-term Outcomes: Work conducted during the five-year period has resulted in:

- Improved nutritional management of transition cows that has translated to approaches to improve animal health, increase milk yield, and improve reproductive performance in dairy herds (NY and IL)
- Identification of metabolic indicators and assessment approaches for hypocalcemia with subsequently improved overall detection and management on farms (NY)
- Developed and utilized *in vitro* methods to evaluate forages and byproducts to determine digestibility, methane emissions and microbial protein synthesis. (NH, MN and SC)
- Evaluated multiple byproducts to improve milk production and nutrient utilization (NE, SD and WI)
- Determined that cows fed canola meal-based diets produced more milk than cows fed soybean meal-based diets, whereas protein concentration of the diet did not affect milk production in early lactation (WI)
- Evaluated individual fatty acids and fatty acid profiles and their effects on milk production and nutrient utilization in lactating dairy cows (CA, IN and MN)
- Utilizing *in vitro* and *in vivo* methods to ameliorate milk fat depression through dietary manipulations (SC)
- Alternative forages such as alkaline-treated corn stover and brown-mid rib sudangrass can be included in lactating dairy cow diets, but result in reduced intake at higher inclusion levels which limits performance.
- Dairy farms have increased adoption of automated milking systems and precision technology exceeding 1,000,000 cows in the United States (KY, MN and WI)
- Shifting organic dairy cow rations to more forage-based and grass-based diets have provided consumers with nutritionally improved dairy products that could potentially reduce the risk of cardiovascular and other metabolic disease by over 25% (NH and MN)

Outputs: Work conducted under Objective 2 has resulted in peer-reviewed journal papers and review articles, conference proceedings, extension publications, and popular press (CA, ID, IN, IL, KY, MI, MN, MO, MS, NC, NE, NH, NY, OH, PA, SC, SD, VA and WI)

- Over 50 Successful Extension Field Days that showcase successful precision technology uses on farms.
- Over 500,000 unique visits a year to Extension Dairy websites that provide information on organic and grazing production systems and precision technology.
- 10+ National webinars in collaboration with eXtension.

Activities: New knowledge and understanding has been gained by the participating stations using a combination of scientific approaches, ranging from *in vitro* and *in vivo* methodologies in laboratory and research farm-based settings as well as collaborative approaches with commercial dairy farms. Collaborative efforts by MN, KY, and WI have evaluated cow sensor technologies and automated milking systems to improve cow and heifer productivity and well-being.

Milestones: Farmers have started to adopt precision technologies to aid in reproductive and health monitoring of cows. Research related to adoption of precision technology has resulted in improved labor efficiency by 10% on farm, as well as improved fertility for dairy cows. Better characterization of byproducts and non-traditional forages and how they can best be incorporated into dairy cattle diets.

Impacts: Research has ranged from improvements in forage management and quality, alternative protein and energy sources, to increased understanding of laboratory methods to evaluate nutrient utilization. It also represents advancements in the nutritional management of lactating cows in both organic and conventional dairy farming systems from different regions of the country. As lactating cows represent the largest sector of the dairy industry and feed cost is a large part of the overall farm budget, this research is also critical to the future success of dairy producers.

Activities: An International Precision Dairy Conference was started with over 200 participants from 6 countries (KY, MN)

Milestones: Increased milk production, reduced feed costs, improved milk quality, improved nutrient utilization in the animal, improved feed efficiency, improved well-being and animal health, reduced impact of animal agriculture on the environment will be promoted through the publication and dissemination of results of scientific trials.

- Inclusion of canola meal as an alternative protein source in diets for dairy cattle resulted in increased milk yield of nearly 10 lbs/day, representing a potential increase in gross revenue for the U.S. dairy industry of more than $5 billion.
- Use of nutritional strategies offers the opportunity to decrease hypocalcemia by more than 50%, improving cow health, milk production, and reproductive performance.
- Long term impacts related to precision technology on dairy farms has the potential to improve labor efficiency by 20%.

Indicators: Adoption of new byproducts and alternative forages by dairy producers in order to increase ration formulation flexibility. Increased adoption of precision agriculture related to dairy production has improved labor efficiency.

OBJECTIVE 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.

Accomplishments:
Short-term Outcomes:

- A large number of farmers were reached by the decision support tools. For example, the number of users of the DairyMGT.info tools exceeded 3,000/year.
- Information disseminated through extension channels reached managers of more than 300,000 cows in different states.
- Participants learned new skills during extension meetings and using curricula we developed. We verified that their knowledge gained was significant and surpassed 20%.

Outputs: Defined products (tangible or intangible) that are delivered by a research project. Examples of outputs are reports, data, information, observations, publications, and patent

- More than 50 decision support tools (developed and/or updated)
- More than 10 extension curricula including educational multimedia videos
- More than 60 Extension publications including fact sheets, newsletters, popular press articles, magazine articles, bulletins, abstracts and proceedings, etc.
- More than 40 research abstracts and proceedings and more than 30 peer reviewed extension and research articles

- A data warehouse located in that collects, stores, and processes most dairy farm streams in a selected number of farms in WI

Activities: In a collaborative effort among ID, MS, NC, NE, and VA, educational extension workshops about holistic management and risk assessment in dairy enterprise have been delivered to dairy farmers, dairy consultants, extension educators, and financial lenders. These workshops are interactive, with short presentations and hands-on exercises using spreadsheets with real examples.

We have developed and deployed a vast number of decision-support tools for practical use at the farm level and for teaching applications. Research on decision support tools has been conducted by ID, MN, VA, and WI. These tools covered almost all areas of decision-making and management in dairy farming, including price risk management; profitability and IOFC; precision dairy farming and robotic milking systems; modernization and expansion; dairy business analysis; herd structure and replacement needs, reproductive assessments; mastitis and health management; genetic management; genomic decision-making; grouping strategies for feeding lactating dairy cattle; and characteristics of organic, grazing, and small conventional dairy farms; and other general management tools such as the use of rbST, milking frequency, feed supplements, and accelerated calf feeding systems. Other educational materials to help farmers and other stakeholders from the dairy industry to improve their management skills were developed.

Several educational curricula including videos (English and Spanish) have been produced in collaboration between VA and ID under the scope of labor management. The videos include trainings related to adequate silo face management using low-technology equipment, newborn calf management, management of compost-bedded pack barns, determining harvesting time for ensiling forages, using winter (cover) crops as feed ingredients for dairy cattle, and preventing silage-related injuries and fatalities among farm workers.

Milestones:

- Decision support tools have been developed, tested, verified, and are readily available for use and application on dairy farms within our extension endeavors
- Technology transfer activities have reached the target populations
- A new set of curricula and videos have been developed and are readily available for continued knowledge transfer

Impacts:

- Facilitated the decision-making of 1,500 dairy farm managers towards improved profitability who used and applied the decision support tools deployed as part of this project
- Managers of 100,000 cows improved dairy farm process control based on information disseminated through our extension channels
- 30,000 stakeholders used educational videos that improved learning skills of employees in dairy farm management

PUBLICATIONS: (Note: Just for 2017-2018)

OBJECTIVE 1:
Peer-reviewed Journal Articles

1. Da Silva, J.T., H. Chester-Jones, and C.M.M. Bittar. 2018. Macronutrient and amino acids composition of milk replacers commercialized in Brazil. Revista Brasileira de Saude e Producao Animal. Vol 19 Jan/March.

2. Dennis, T.S., F.X. Suarez-Mena, T.M. Hill, J.D. Quigley, R.L. Schlotterbeck, and G.J. Lascano. 2017. Effect of replacing corn with beet pulp in a high concentrate diet fed to weaned Holstein calves on diet digestibility and growth. J Dairy Sci. 101:408-412

3. Dennis, T.S., F.X. Suarez-Mena, T.M. Hill, J.D. Quigley, RL Schlotterbeck, RN Klopp, G.J. Lascano and L. Hulbert. 2018. Effects of gradual and later weaning ages when feeding high milk replacer rates on growth, textured starter digestibility, behavior in Holstein calves from 0 to 4 months of age. J Dairy Sci. 101:1-13.

4. Heinrichs, A.J., GF., Zanton., G.J. Lascano and C. Jones. 2017. Invited Review: 100 years of dairy heifer research. J Dairy Sci. 100:10173-10188.

5. Heinrichs, A.J. B. S. Heinrichs, C. M. Jones, P. S. Erickson, K. F. Kalscheur, T. D. Nennich, B. J. Heins, and F. C. Cardoso. 2017. Short communication: Verifying Holstein heifer heart girth to body weight prediction equations. J. Dairy Sci. 100:8451-8454.

6. Kertz, A. F., T.M. Hill, J.D. Quigley III, A.J. Heinrichs, J.G. Linn, J.K. Drackley,. 2017. A 100-Year Review: Calf nutrition and management.. J. of Dairy Sci.100:10151–10172

7. Klopp, R.N., M.J. Oconitrillo, A. Sackett, M. Hill, R. Schlotterbeck and G.J. Lascano. 2018. Technical Note: A Simple Rumen Collection Device for Calves: An Adaptation of a Manual Rumen Drenching System. J Dairy Sci. 101: 6555-6558.

8. Koch, L.E. N.A. Gomez, Bowyer, A., and G.J. Lascano, 2017. Precision-feeding dairy heifers a high rumen undegradable protein diet with different proportions of dietary fiber and forage to concentrate ratios. J Anim. Sci. 95:5617-5628.

9. Lawrence, R. D., and J. L. Anderson. 2018. Ruminal degradation and intestinal digestibility of camelina meal and carinata meal compared to other protein sources. Prof. Anim. Sci. 34: 10-18.

10. Manthey, A. K., and J. L. Anderson. 2018. Growth performance, rumen fermentation, nutrient utilization, and metabolic profile of dairy heifers limit-fed distillers dried grains with ad libitum forage. J. Dairy Sci. 101:365-375.

11. Pino, F., N.L. Urrutia, S.L. Gelsinger, A.M. Gehman, and A.J. Heinrichs. 2018. Long-term effect of organic trace minerals on growth, reproductive performance, and first lactation in dairy heifers. Prof. Animal Scientist. 34: 51–58.

12. Pino, F., L. K. Mitchell, C. M. Jones and A. J. Heinrichs. 2018. Comparison of diet digestibility, rumen fermentation, rumen rate of passage, and feed efficiency in dairy heifers fed ad-libitum versus precision diets with low and high quality forages. J. Appl. Animal Res. 46:1296-1306.

13. Ort, S.B., A. Brito, D. J. Schauff, and P. S. Erickson. 2018. The impact of direct-fed microbials and enzymes on the health and performance of dairy cows with emphasis on colostrum quality and serum immunoglobulin concentrations in calves. J. Anim. Phys. Anim. Nutr. 102: e641-e652.

14. Rauba, J., B. Heins, H. Chester-Jones, H. Diaz, D. Ziegler, J. Linn, and N. Broadwater. 2018. Relationships between protein and energy consumed from milk replacer and lactation production of Holstein dairy cows. J. Dairy Sci.(in press).

15. Rodriguez-Hernandez, K. and J. L. Anderson. 2018. Evaluation of carinata meal as a feedstuff for growing dairy heifers: Effects on growth performance, rumen fermentation, and total tract digestibility of nutrients. J. Dairy Sci. 101:1206-1215.

16. Schossow, C.R. J. L. Anderson. 2018. Evaluation of solubles syrup from microbially-enhanced soy protein production as a supplement for growing dairy heifers. Prof. Anim. Sci. *Accepted*.

17. Senvirathne, N.D., J. L. Anderson, and M. Rovai. 2018. Growth performance and health of dairy calves given water treated with a Reverse Osmosis System compared to Municipal City Water. J. Dairy Sci. 101:8890-8901.

18. Soder, K.J., B.J. Heins, H. Chester-Jones, A.N.Hafla, and M.D. Rubano. 2018. Evaluation of fodder production systems for organic dairy farms. The Prof. Anim. Scientist. 34, Issue 1, pp 75-83.

19. Su. H., M.S. Akins, N. M. Esser, R. Ogden, W. K. Coblentz, K. F. Kalscheur, R. D. Hatfield. 2017. Effects of feeding alfalfa stemlage or wheat straw for dietary energy dilution on nutrient intake and digestibility, growth performance, and feeding behavior of Holstein dairy heifers. J. Dairy Sci 100:7106-7115.

20. Tacoma, R., S.L. Gelsinger, Y.W. Lam, R.A. Scuderi, D.B. Ebenstein, A.J. Heinrichs, and S.L. Greenwood. 2017. Exploration of the bovine colostrum proteome and effects of heat treatment time on colostrum protein profile. J. Dairy Sci. 100: 9392–9401.

21. Williams, K., K. Weigel, W. Coblentz, N. Esser, H. Schlesser, P. Hoffman, H. Su, M. Akins. Effect of diet energy density and genomic residual feed intake on bred dairy heifer growth, feed efficiency, and manure excretion. J. Dairy Sci. Submitted August 6, 2018.

Abstracts

1. Chishti, A. I., I. Saffer, X, J, Suarez-Mena, and A. J. Heinrichs. 2018. Effect of age and physical form of oats within calf starter on hepatic enzyme expression in preweaned dairy calves. J Dairy Sci. 101 Suppl 1:89.

2. Heins, BJ.,H Chester-Jones, D Ziegler, N Broadwater; 75 Relationships between Early-Life Growth and Protein and Energy Intake with First-Lactation Performance of Holstein Dairy Cows., Journal of Animal Science, Volume 96, Issue suppl_2, 10 April 2018, Pages 39, https://doi.org/10.1093/jas/sky073

3. Heinrichs, A. J. 2018. Growing and developing dairy heifers from birth to weaning. J. Dairy Sci. 101 Suppl 1:379.

4. Klopp, R.N., T. M. Hill, F.X. Suarez-Mena, R.L. Schlotterbeck, and G.J. Lascano. 2018. Effects of feeding different amounts of milk replacer on nutrient digestibility in Holstein calves to 2 months of age using different weaning transition strategies. J. Dairy Sci. Supl. 2.

5. Klopp, R.N., T. M. Hill, F.X. Suarez-Mena, R.L. Schlotterbeck, and G.J. Lascano. 2018. Effects of feeding different amounts of milk replacer on growth performance in 2- to 4-month-old Holstein calves using different weaning transition strategies. J. Dairy Sci. Supl. 2.

6. Lawrence, R. D., and J. L. Anderson. 2018. Evaluation of carinata meal included in a total mixed rations fed ad libitum to dairy heifers. J. Dairy Sci. 101. Suppl. 2: 389. (Abstr. 437). (ADSA Annual Meeting).

7. Mitchell, L. K. and A. J. Heinrichs. 2018. Impact of converting weaned dairy calves from a component-fed to a total mixed ration on growth and nutrient digestibility. J Dairy Sci. 101 Suppl 1:290.

8. Mitchell, L. K. and A. J. Heinrichs. 2018. Impact of various forages and live yeast culture on weaned dairy calf growth and nutrient digestibility. J Dairy Sci. 101 Suppl 1:293.

9. Phillips. H.N., B. J. Heins. Physiological and behavior response of dairy calves disbudded with oral administration of an herbal tincture as a method to reduce pain and stress. J. Dairy Sci. Vol. 101, Suppl. 2 Abstr 371.

10. Rauba, J., B.J. Heins, H. Chester-Jones, H.L. Diaz, D. Ziegler, J. Linn, and N. Broadwater. 2018. Pre- and Relationships between protein and energy consumed from milk replacer and starter and first lactation production performance of Holstein dairy cows. J. Dairy Sci. 101(Suppl.2):389. Abstract 435.

11. Rice, E.M., K. M. Aragona, and P. S. Erickson. 2018. Supplementation of sodium butyrate to post-weaned heifer diets: Effects on growth performance, nutrient digestibility, and health. J. Dairy Sci. 101 (Suppl.2): 305.

12. Rodriguez-Hernandez, K. J. L. Anderson, J. A. Clapper, and G. A Perry. 2018. Metabolic profile of Holstein heifers fed carinata meal compared with canola meal and a control diet. J. Dairy Sci. 101: Suppl. 2: 104 (Abstr. 30 & M277). (ADSA Annual Meeting).

13. Rodriguez, K., and J. L. Anderson. 2018. Growth performance of dairy heifers fed carinata meal compared with canola meal and a control diet. J. Dairy Sci. 101. Suppl. 2: 389 (Abstr. 436). (ADSA Annual Meeting).

14. Saldana, D. J., S. L. Gelsinger, C. M. Jones, and A. J. Heinrichs. 2018. Effects of different heating time of high, medium, or low quality colostrum on IgG absorption in dairy calves. J Dairy Sci. 101 Suppl 1:277.

15. Schossow, C. R., J. L. Anderson, and J. S. Osorio. 2018. Growth performance and health of dairy calves supplemented with flax and soy oil. J. Dairy Sci. 101. Suppl. 2: 391 (Abstr. 442). (ADSA Annual Meeting).

16. Senevirathne, N.D., J. L. Anderson, J. S. Osorio, L. Metzger, and B. St Pierre. 2018. Growth performance, nutrient utilization, and health of calves supplemented with condensed whey solubles. J. Dairy Sci. 101. Suppl. 2: 390 (Abstr. 439). (ADSA Annual Meeting).

17. Suarez-Mena, F.X., Dennis, T. M. Hill, W. Hu, J. D. Quigley, R.L. Schlotterbeck, R.N. Klopp, G. J. Lascano, L. E. Hulbert. 2018. Effect of previous milk replacer feeding program on calf performance and digestion from 2 to 4 mo of age.. J. Dairy Sci. Supl. 2.

18. Ziegler, D., H. Chester-Jones, R. Blome, and D. Wood. 2018. Pre- and post weaning performance and health of dairy calves fed milk replacers formulated with 5 or 10% levels of spray dried bovine plasma. J. Dairy Sci. 101(Suppl.2):115-116. Abstract M310

19. Ziegler, D., H. Chester-Jones, B. Ziegler and A. Manthey. 2018. Pre- and post weaning performance and health of dairy calves fed milk replacers supplemented with egg antibodies, direct fed microbials, neomycin sulfate and oxytetracycline J. Dairy Sci. 101(Suppl.2):230. Abstract T41.

20. Ziegler, D., H. Chester-Jones, T. Marubash and R. Shimizu. 2018. Pre- and post weaning performance and health of dairy calves fed milk replacers supplemented with an organic direct-fed microbial or neomycin sulfate and oxytetracyline. J. Dairy Sci. 101(Suppl.2):230-231. Abstract T42.

21. Ziegler, D., H. Chester-Jones, B.E. Ziegler, A.K. Manthey, and J. Olson. 2018. Pre- and post-weaning performance and health of dairy calves fed milk replacer supplemented with direct-fed microbials or neomycin sulfate and oxytetracyline. J. Dairy Sci. 101(Suppl.2):231. Abstract T43.

Extension Articles

1. Cantor, M.C., A.L. Stanton and J.H.C. Costa. Milk feeding strategy and its influence on development of feeding behavior for dairy calves in automated feeding systems. (2018). In: International Society of Applied Ethology Conference (ISAE), Annual Meeting, 2018, Prince Edward Island, Canada. 19.

2. Erickson, P.S. 2018. Limit feeding dairy heifers. https://extension.unh.edu/blog/limit-feedingdairy-heifers

3. Falk, M.L., M.C. Cantor, M. Hayes, J. Jackson, and J. H. C. Costa. Validation of radio frequency identification with a current transducer to quantify the use of an automatic grooming brush in pre-weaned dairy calves. (2018). In: An American Society of Agricultural andBiological Engineers (ASABE). 10th International Environmental Livestock Symposium, 2018, Omaha, NE, USA

4. France, T.L., Amaral-Phillips, D.M., Costa, J.H.C. (2018). "Cleaning Out and Restarting your Compost Bedded Pack Barn". Kentucky Dairy Notes. October, 2018. (Print and Web).

5. Grinter, L. N., D. M. Amaral-Phillips, and J. H. C. Costa. (2018). "When and how to disbud dairy calves: short- and long-term pain management and the latest scientific information". Kentucky Dairy Notes, September, 2018. (Print and Web).

6. Mazon, G., Amaral-Philiphs. D., Costa, J. H. C. (2018). "Getting the Most from Automatic Dairy Calf Feeders". Kentucky Dairy Notes, August, 2018. (Print and Web).

OBJECTIVE 2:

Peer-reviewed Journal Articles

1. Acosta, D.A., A. Schneider, C.B. Jacometo, J.A. Rincon, F.C. Cardoso, and M.N. Corrêa. (2017). Effect of somatotropin injection in late pregnant Holstein heifers on metabolic parameters and steroidogenic potential of the first postpartum dominant follicle. Theriogenology. 104:164-172.

2. Alende, M., G. J. Lascano, T.C. Jenkins, L. E. Koch, G. Volpi-Lagreca, and J.G. Andrae. 2018**.** Comparison of four methods for determining *in-vitro* ruminal digestibility of annual ryegrass. 2018. PAS. 34: 306-309.

3. Batistel, F., J.M. Arroyo, C. Matamoros, E. Trevisi, C. Parys, M. Ballou, F.C. Cardoso, and J.J. Loor. (2018). Ethyl-cellulose rumen-protected methionine alleviates inflammation and oxidative stress and improves neutrophil function during the periparturient period and early lactation in Holstein dairy cows. Journal of Dairy Science. 101:480-490.

4. Benbrook, C.M., D.R. Davis, B.J. Heins, M.A. Latif, C. Leifert, L. Peterman, G. Butler, O. Faergeman, S. Abel-Caines, and M. Baranski. 2018. Enhancing the fatty acid profile of milk through forage-based rations, with nutrition modeling of diet outcomes. Food Science & Nutrition 6:681–700. doi:10.1002/fsn3.610.

5. Herrick, K.J., A.R. Hippen, K.F. Kalscheur, D. J. Schingoethe, S.D. Ranathunga, J. L. Anderson, S.C. Moreland, and J.E. van Eys. 2018. Infusion of butyrate affects plasma glucose, butyrate, and β-hydroxybutyrate but not plasma insulin in lactating dairy cows. J. Dairy Sci. 101:3524–3536.

6. Koch, L.E. and G.J. Lascano. 2018. Milk Fat Depression: Etiology, theories, and soluble carbohydrate interactions. J. Anim. Res. Nutr. *3:* 2-12.

7. Kienitz, M.J., B.J. Heins, and R.D. Moon. 2018. Evaluation of a commercial vacuum fly trap for controlling flies on organic dairy farms. J. Dairy Sci. 101:4667–4675. doi:10.3168/jds.2017-13367.

8. Leno, B. M., E. M. Martens, M.J.B. Felippe, K. P. Zanzalari, J. C. Lawrence, and T. R. Overton. 2017. Short communication: Relationship between methods for measurement of serum electrolytes and the relationship between ionized and total calcium and neutrophil oxidative burst activity in early postpartum dairy cows. J. Dairy Sci. 100:9285-9293.

9. Leno, B. M., R. C. Neves, I. M. Louge, M. D. Curler, M. J. Thomas, T. R. Overton, and J.A.A. McArt. 2018. Differential effects of a single dose of oral calcium based on postpartum plasma calcium concentration in Holstein cows. J. Dairy Sci. 101:3285-3302.

10. Maki, C.R., Allen, S., Wang, M., Ward, S.H., Rude, B.J., Bailey, H.R., Harvey, R.B., Phillips, T.D. 2017. Calcium montmorillonite clay for the reduction of aflatoxin residues in milk and dairy products. Journal of Dairy and Veterinary Sciences. 2(3):1-8.

11. Neves, R. C., B. M. Leno, M. D. Curler, M. J. Thomas, and J.A.A. McArt. 2018. Association of immediate postpartum plasma calcium concentration with early-lactation clinical diseases, culling, reproduction, and milk production in Holstein cows. J. Dairy Sci. 101:547-555.

12. Overton, T. R., J.A.A. McArt, and D. V. Nydam. 2017. A 100-Year Review: Metabolic health indicators and management of dairy cattle. J. Dairy Sci. 100:10398-10417.

13. Pate, R.T., and F.C. Cardoso. (2018). Injectable trace minerals (selenium, copper, zinc, and manganese) alleviates inflammation and oxidative stress during an aflatoxin challenge in lactating multiparous Holstein cows. Journal of Dairy Science. doi: 10.3168/jds.2018-14447

14. Pereira, G.M., B.J. Heins, and M.I. Endres. 2018. Technical note: Validation of an ear-tag accelerometer sensor to determine rumination, eating, and activity behaviors of grazing dairy cattle. Journal of Dairy Science 101:2492–2495. doi:10.3168/jds.2016-12534.

15. Ranathunga, S.D., K.F. Kalscheur, A.D. Garcia, and D.J. Schingoethe. 2018. Fermentation characteristics and feeding value of ensiled wet corn distillers grains in combination with wet beet pulp for lactating dairy cows. Prof. Anim. Sci. 34:346-355.

16. Rodriguez-Jimenez, S., K. J. Haerr, E. Trevisi, J.J. Loor, and F. C. Cardoso, and J. S. Osorio. 2018. Prepartal standing behavior as a parameter for early detection of subclinical ketosis in postpartal dairy cows. Journal of Dairy Science. doi.org/10.3168/jds.2017-14254.

17. Ruh, K.E., B.J. Heins, I.J. Salfer, R.D. Gardner, and M.D. Stern. 2018. Comparison of warm season and cool season forages for dairy grazing systems in continuous culture. Trans Anim Sci 2:125–134. doi:10.1093/tas/txy014.

18. Skenandore C.S. and F.C. Cardoso. 2017. The effect of tail paint formulation and heifer behavior on estrus detection. International Journal of Veterinary Science and Medicine. 5:113-120.

19. Soder, K.J., B.J. Heins, H. Chester-Jones, A.N. Hafla, and M.D. Rubano. 2018. Evaluation of fodder production systems for organic dairy farms. Prof Ani Sci 34:75–83. doi:10.15232/pas.2017-01676.

20. Stella, S. L., D. A. Acosta, C. Skenandore, Z. Zhou, A. Steelman, D. Luchini, and F.C. Cardoso. 2018. Improved uterine immune mediators in Holstein cows supplemented with rumen-protected methionine and discovery of neutrophil extracellular traps (NET). Theriogenology. 114:116-125.

21. Weatherly, M., R.T. Pate, G. E. Rottinghaus, F.O. Roberti-Filho, and F.C. Cardoso. 2018. Physiological responses to a yeast and clay-based adsorbent during an aflatoxin challenge in Holstein cows. Animal Feed Science Technology. 235:147-157.

22. Xu, T., F.C. Cardoso, A. Pineda, E. Trevisi, X. Shen, F. Rosa, J. Osorio, and J.J. Loor. 2017. Grain challenge affects systemic and hepatic molecular biomarkers of inflammation, stress, and metabolic responses to a greater extent in Holstein than Jersey cows. Journal of Dairy Science. 100:9153-9162.

Abstracts

1. Adamczyk M.D., L.N. Grinter, A.R. Lee, J.M. Bewley, and J.H.C. Costa. 2018. Automatic feed push-up frequency effects on dairy cattle behavior and milk production. American Dairy Science Association (ADSA) Annual Meeting. 2018, Knoxville, Tennessee, USA.

2. Adamczyk, M.D., L.N. Grinter, A.R. Lee, J.M. Bewley, and J.H.C. Costa. In: How does feed push-up frequency affect dairy cattle behavior and milk production? .(2017). In: Tri-State Dairy Nutrition Conference. 2018, Fort Wayne, IN, USA.

3. Allen, S. C. Z. A. Mason, B. J. Rude, R. H. Bailey, A. Hoang, D. L. Sparks, A. B. Johnson, and S. H. Ward. 2017. Abstr# M246. Reduction of aflatoxin transfer into milk of lactating dairy cows with the addition of a commercial clay. J. Dairy Sci. Vol. 100 (Suppl. 2):95.
4. Allen, S. C. Z. A. Mason, B. J. Rude, R. H. Bailey, C. Maki, T. Phillips and S. H. Ward. 2017. Abstr#40. Efficacy of calcium montmorillonite clay at reducing aflatoxin transfer in lactating Holsteins fed a known concentration of aflatoxin. J. Dairy Sci. Vol. 100 (Suppl. 2):135

5. Aragona, K.M. and P. S. Erickson. 2018. Effects of supplemental β-carotene to lactating Holstein cows on production and rumen fermentation. J. Dairy Sci. 101 (Suppl.2): 321-322.

6. Boerman, J. P. T. S. Steckler, and N. Lopez-Villalobos. 2018. The effects of milk consumption on predicted future body weight of heifers**.** J. Dairy Sci. 101 (Suppl.2): 321-322.

7. Cecil, C. P., G. Mazon, and J. H. C. Costa. Comparison between non-dairy milk-like beverages and cow's milk. (2018). American Dairy Science Association Annual Meeting (ADSA), Knoxville, TN, USA.

8. Grinter, L.N., and J.H.C. Costa. Validation of a behavior monitoring collar system for dairy cows; can it measure feeding, ruminating and resting reliably?. (2018). In: Tri-State Dairy Nutrition Conference. 2018, Fort Wayne, IN, USA.

9. Jenkins, T.C., K. Murphy, S. J. Saunier, G. J. Lascano, N. M. Long. 2018. Crosslinking of protein capsules containing fish oil reduces their disintegration rate in ruminal contents but allows rapid fatty acid release in intestinal proteases. J. Dairy Sci. Suppl. 2.

10. Heins, B J H Chester-Jones, D Ziegler, N Broadwater; 75 Relationships between Early-Life Growth and Protein and Energy Intake with First-Lactation Performance of Holstein Dairy Cows., Journal of Animal Science, Volume 96, Issue suppl_2, 10 April 2018, Pages 39, https://doi.org/10.1093/jas/sky073.073

11. Koch, L.E., B.M. Koch, R.N. Klopp, M.J. Oconitrillo, R. Hughes, M. Courey, A. Sackett, T. C. Jenkins, and G.J. Lascano. 2018. Replacing dietary starch with a combination of sugar and soluble fiber in combination with soybean oil alter lactating performance in Holstein dairy cows. J. Dairy Sci. Suppl. 2.

12. Koch, L.E., B.M. Koch, R.N. Klopp, M.J. Oconitrillo, R. Hughes, M. Courey, A. Sackett, T. C. Jenkins, and G.J. Lascano. 2018. Replacing dietary starch with a combination of sugar and soluble fiber in combination with soybean oil alters fermentation in continuous culture. J. Dairy Sci. Suppl. 2.

13. Kerwin, A. L., C. M. Ryan, B. M. Leno, M. Jaksobsen, P. Theilgaard, and T. R. Overton. 2018a.The effect of feeding Zeolite A during the prepartum period on peripartum performance in multiparous Holstein cows. J. Dairy Sci. 101(Suppl. 2):106.

14. Kerwin, A. L., C. M. Ryan, B. M. Leno, M. Jaksobsen, P. Theilgaard, and T. R. Overton. 2018b. The effect of feeding Zeolite A during the prepartum period on serum mineral concentrations in multiparous Holstein cows. J. Dairy Sci. 101(Suppl. 2):105-106.

15. Kerwin, A. L., C. M. Ryan, A. Richards, and T. R. Overton. 2018c. Relationships of TMR factors with sorting of prefresh dry period rations and postpartum subclinical ketosis in dairy herds fed anionic diets prepartum. J. Dairy Sci. 101(Suppl. 2):311.

16. Krogstad, K.C., J. L. Anderson, J. S. Osorio, and K. J. Herrick. 2018a. In vitro ruminal dry degradability and volatile fatty and gas production of DDGS with varying fat content. J. Dairy Sci. 101: Suppl. 2: 97 (Abstr. M255) (ADSA Annual Meeting).

17. Krogstad, K.C., J .L. Anderson, J. S. Osorio, and K.J. Herrick. 2018b. In situ ruminal dry matter and fiber degradability of distillers dried grains with solubles with varying fat content by lactating dairy cows. J. Dairy Sci. 101. Suppl. 2: 301 (Abstr. T242). (ADSA Annual Meeting).

18. LaCount, S. E., C. M. Ryan, M. E. Van Amburgh, and T. R. Overton. 2018. Performance and metabolism of multiparous Holstein dairy cows as affected by corn silage type and supplementation with monensin throughout the transition period. J. Dairy Sci. 101(Suppl. 2):95-96.

19. Leal-Yepes, F. A., S. Mann, T. R. Overton, J. J. Wakshlag, and D. V. Nydam. 2018. Postpartum supplementation with rumen-protected branched-chain amino acids: Effects on production and plasma metabolites. J. Dairy Sci. 101(Suppl. 2):147.

20. Mazon, G., C. Holcomb, J. M. Bewley, and J. H. C. Costa. Effects of a Megasphaera elsdenii oral drench on rumen pH, feed intake, and milk yield in lactating dairy cows. (2018). American Dairy Science Association Annual Meeting (ADSA), Knoxville, TN, USA

21. Moore, S.A.E., and K.F. Kalscheur. 2018. Evaluation of a limit feeding strategy with canola or soybean meals on dairy cow performance. J. Dairy Sci. 101 (Suppl. 2):296.

22. Mullins, I. L., C. M. Truman, J. M. Bewley, and J.H.C. Costa. Validation of an Automated Body Condition Scoring Technology for Dairy Cattle. (2018). In: Tri-State Dairy Nutrition Conference, 2018, Fort Wayne, IN, USA.

23. Ostendorf, K.L., and K.F. Kalscheur. 2018a. Effect of source and processing of protein feedstuffs pelleted with treated corn stover in dairy cow diets. J. Dairy Sci. 101 (Suppl. 2):417.

24. Ostendorf, K.L., and K.F. Kalscheur. 2018b. Production performance in lactating dairy cows fed treated corn stover pelleted with soybean meal or distillers grains. J. Dairy Sci. 101 (Suppl. 2):317.

25. Pereira, G. M., B. J. Heins, M. I. Endres. K. Minegeshi. 2018. Estrus detection with an activity and rumination monitoring system in an organic grazing and in a low-input conventional herd. J. Dairy Sci. Vol. 101, Suppl. 2 Abstr 97.

26. Pereira, G. M., B. J. Heins. 2018. Activity and rumination of Holstein versus crossbred cows in an organic grazing and low-input conventional herd. J. Dairy Sci. Vol. 101, Suppl.2 Abstr 390.

27. Phillips. H.N., B. J. Heins, Physiological and behavior response of dairy calves disbudded with oral administration of an herbal tincture as a method to reduce pain and stress. J. Dairy Sci. Vol. 101, Suppl. 2 Abstr 371.

28. Rauba, J.J., B.J. Heins, H. Chester-Jones, H. L. Diaz, D. Ziegler, J. Linn, N. Broadwater. Relationships between birth season and protein and energy consumed from milk replacer and starter on calf growth and first lactation production performance of Holstein dairy cows. J. Dairy Sci. Vol. 101, Suppl. 2 Abstr 435.

29. Ranck, E.J. and L. A. Holden. 2018. Evaluating forage and feed costs perhundredweight of milk sold on four dairy farms double cropping winter annuals with corn silage in northern and western Pennsylvania. J. Dairy Sci. 101 Suppl. 1:44.

30. Shearer, L.K., J. L. Anderson, J. S. Osorio, and K. Mjoun. 2018. Lactation performance and feed efficiency of dairy cows fed freshly ensiled corn silage-based diets with exogenous amylase and protease. J. Dairy Sci. 101. Suppl. 2. 303 (Abstr.T247) (ADSA Annual Meeting).

31. Sanchez-Duarte, J.I., and K.F. Kalscheur. 2018. Replacing cereal grains starch with non-forage fiber in diets of dairy cows: a meta-analysis. J. Dairy Sci. 101 (Suppl. 2):298.

32. Woodrum, M. M., G. Mazon, and J. H. C. Costa. Automated temperature Reading systems to detect fever in dairy cattle. (2018). American Dairy Science Association Annual Meeting (ADSA), Knoxville, TN, USA.

OBJECTIVE 3:

Peer-reviewed Journal Articles

1. Jabarzareh, A., A. Sadeghi-Sefidmazgi, G. Ghorbani, and V. E. Cabrera. 2018. Economic evaluation of sexed semen use in Iranian dairy farms according to field data. Reprod Domestic Anim. 2018;1–8.

2. Mur-Novales, R., F. Lopez-Gatius, P. Fricke, V. E. Cabrera. 2018. An economic evaluation of management strategies to mitigate the negative impact of twinning in dairy herds. Journal of Dairy Science 101:8335–8349.

3. Cabrera, V. E. 2018. Helping dairy farmers to improve economic performance utilizing data-driving decision support tools. Animal 12(1):134-144.

4. Cordoba, M. C., P. L. Ruegg, R. D. Shaver, K. A. Weigel, P. D. Carvalho, P. M. Fricke, and V. E. Cabrera. 2018. Repro Money: an Extension program to improve dairy farms' reproductive performance. Journal of Extension 56:2-16263RIB.
5. Liang, D., Arnold, L. M., Stowe, C. J., Harmon, R. J., & Bewley, J. M. 2017. Estimating US dairy clinical disease costs with a stochastic simulation model. Journal of dairy science, 100(2), 1472-1486.

6. Dolecheck, K., & Bewley, J. 2018. Animal board invited review: Dairy cow lameness expenditures, losses and total cost. animal, 1-13.

7. Dolecheck, K. A., Dwyer, R. M., Overton, M. W., & Bewley, J. M. 2018. A survey of United States dairy hoof care professionals on costs associated with treatment of foot disorders. Journal of dairy science, 101(9), 8313-8326.

Abstracts

1. Delgado, H., D. Liang, and V. E. Cabrera. 2018. The lifetime impact of a clinical mastitis case during the first 100 lactation days in first lactation. Journal of Dairy Science 101: (Suppl. 2): 3267.

2. Liang, D., A. Golechha, V. E. Cabrera, and J. Patel. 2018. Predicting clinical mastitis at 30 to 60 DIM using an integrated real-time data warehouse. Journal of Dairy Science 101: (Suppl. 2): 327.

3. Wangen, S. R., H. D. Rodriguez, D. Liang, A. Christensen, M. Ferris, and V. E. Cabrera. 2018. Development of an integrated dairy farm decision sup- port system to facilitate dairy management-I. Data integration and warehousing. Journal of Dairy Science 101: (Suppl. 2): 320.

4. White, H., and V. E. Cabrera. 2018. Data up to your eyeballs? 2018 Professional Dairy Producers of Wisconsin Business Conference. Alliant Energy Center, Madison, 14-15 March 2018.