NC-2042 –Management Systems to Improve the Economic and Environmental Sustainability of Dairy Enterprises.

Minutes from 2019 Business Meeting
October 17th 2019

Participants: Matt Akins (University of Wisconsin), Gustavo Lascano (Clemson University), Gonzalo Ferreira (Virginia Tech), Pete Erickson (University of New Hampshire), Jackie Boerman (Purdue University), Phil Cardoso (University of Illinois), Joao Costa (University of Kentucky), Victor Cabrera (University of Wisconsin), Brad Heins (University of Minnesota), Ken Kalscheur (USDA Dairy Forage Research Center), and Matias Aguerre (Clemson University).

Meeting called to order by Gustavo Lascano (Chair)

Revision of minutes from previous meeting

- GF requested an amendment. Correct Mireille Chahine's name.
- KK requested two amendments. Correct his name (twice).
- PE requested two amendment. PE did not claim travel funds (delete). PE stresses the discoordination between UNH and NIFA, who requests projects renewals every 3 and 5 years, respectively.
- PE moves to approve the minutes after corrections. KK seconds. Nobody opposed. Minutes are approved.

Discussion about performing more collaborative work

- Generally speaking, the group needs to collaborate more.
- VC said we need a champion when applying for a grant.

Communication with Steve Smith (USDA – NIFA)

- Dr. Angle is the new director.
- NIFA and ERS relocated. Still in transition.
- Budget. File shared with the group. Not a lot of concerns over the budget. Decrease of staff due to transition (20% of staff of initial staff). Award management is a critical function. Actively recruiting. Be patient.
- Programs. Little new to talk about. Foundational program, show variables of interest for Animals Nutrition, Growth and Lactation). Exploratory program gone away. CARE for a while and for extension activities. IDEAS has been under-solicited (up to $1,000,000 award cross-cutting issues). Duel benefit program, has a sunset, workshop in May. How to carry this into new program? Watch NSF.
- New hire and more on NIFA transition. Please be patience with us.
- Q&A
  - PC: IDEAS allocation? SS: Nothing will jeopardize the IDEAS program.
  - GL: coordinated efforts, better chances? SS: It depends on the program. Coordinated efforts for $500,000 might not be good. Coordinated efforts for SAS Program… absolutely. Pay

attention to (SAS) letter of intent (i.e., around June 2020). Very specific items in LOI. If it is there you have a checkmark. If not invited, way outside or not following LOI instructions. September 2020 should be the deadline for proposal. Economic scope needed in SAS.

Communication with Dave Benfield (advisor)

- Hatch funds. Senate moving to increase funding. Some of you get project money, others get salaries. Is up to institution.
- Consolidating 40 lines of priorities to 5-10. Small grants are not even seen.
- Station report due 60 days from today.
- It has been noticed that some stations are not showing up for meetings. Please communicate Dr. Benfield of stations not participating in annual conferences and mot sending reports.
- Benfield is retiring. Shawn Donkin (Purdue University) will be the new advisor in January 2020.

Next meeting

- Date: October 8-10, 2020.
- Host: Tom Overton (Cornell University).
- Chair: Mireille Chahine (University of Idaho).
- Secretary: Phil Cardoso. Motion by GF. KK seconds. All approved. None opposed.

International trip 2021

- Two proposed ideas:
  - Ecuador/Peru, proposed by GL and VC.
  - Prince Edward Island, proposed by PE.
- This should be decided in 2020.
- Have proposal by Dec 15.
- Vote by e-mail.

ADSA Symposium

- Initial proposal (2017) rejected. Resubmitted by VC in 2018.
- Everything came along too quickly. We needed to fill up the space and invited Alex Bach as speaker.
- Very good attendance (room full most of the time). No feedback, though.
- VC chaired.
- All invited to submit a paper.
- This should count as outcome from the group.

Meeting adjourned

Management Systems to Improve the Economic and Environmental Sustainability of Dairy Enterprises (NC-2042)

Annual Station Reports

October 1, 2018 – September 30, 2019

Contributing Agricultural Experiment Stations and Alphabetical Order of Reports

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Period covered: October 1, 2018 to September 30, 2019

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) 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.

Clemson University (Lascano/Aguerre)

Project title: Management Systems to Improve Economic and Environmental Sustainability of Dairy Enterprises

Cooperating Agency: Clemson University Agricultural Experiment Station, Clemson, SC 29634

Personnel: Gustavo J. Lascano, Department of Animal and Veterinary Sciences (PI)
Matias J. Aguerre, Department of Animal and Veterinary Sciences (Co-PI)
Saad Hussein, Department of Animal and Veterinary Sciences (Ph.D. Student)
Becca Klopp, Department of Animal and Veterinary Sciences (M.Sc. Student)
Monica Toledo (Visiting Scholar and M.Sc. student)
Madeline Oskey, Department of Animal and Veterinary Sciences (M.Sc. Student)
Manuel Peña, Department of Animal and Veterinary Sciences (M.Sc. Student)
Chandler Compton, Department of Anim. and Veterinary Sciences (M.Sc. Student)
Jing Echesabal (Laboratory Technician)

Lascano

Project Methods:

Objective 1:

Work was completed looking at weaning strategies and milk replacer (MR) regime before and after weaning to improve the adaptation during this transition period. Three *in-vitro* projects looking at the effects of using high concentrations of fat in precision fed system for heifers were completed

Objective 2:

Three projects were conducted under this objective to improve nutrient utilization efficiency and animal health. An *in-vitro* and *in-vivo* projects were undertaken continuing our work of evaluating rumen modifiers and ameliorating Milk Fat depression through dietary manipulations.

Two *in-vivo* projects were conducted with the objective to determine if a treatment process applied to protein capsules containing fish oil slowed protein disintegration time in rumen buffer and prevented biohydrogenation of internal omega fatty acids in lactating dairy cows. A third project used continuous culture fermentation to determine the effects of caffeine on rumen fermentation, digestibility coefficients and microbial flow.

Project Outputs:

Objective 1:

The pre weaning and postweaning effects of different transition strategies have been published in JDS or submitted (Klopp et al. 2019a, Klopp et al., 2019b). Another manuscript, looking at the microbial profile changes during this transition period is being completed in collaboration with University of Maine. Three abstracts related to using high concentration of fat in precision feeding regimes were presented at ADSA and are currently in preparation for submission to peer-review journals.

Objective 2:

Previous work looking at the effects of manipulating starch degradability on milk fat depression was published in JDS. An abstract looking at the effects of caffeine on rumen fermentation and nutrient utilization was presented at ADSA conference in Cincinnati. The rumen protection technology developed in vitro is currently being tested in vivo.

Impacts:
When feeding calves moderate amounts of MR, gradual weaning seems not to affect successful growth and development. However, when high amounts of MR are provided, it is necessary to wean them gradually to allow them to adapt to solid feed consumption prior to weaning, enhance rumen development, microbial establishment and increase feed efficiency.

Evaluating rumen protection technology is under way using in-vivo approaches.

Increasing levels of fat under precision feeding system showed a potential to reduce DMI yet maintain optimal rumen fermentation conditions and nutrient utilization.

Aguerre

Effect of different cutting intervals on yield and forage quality of low lignin and conventional alfalfa under southeastern conditions.

The objective of the study is to evaluate the effect of harvest interval and variety on forage yield and quality. The study is been conducted as a RCBD with a split-plot arrangement of treatments. Main-plot factor is harvest interval (28, 35 and 42 d) and sub-plot factor is alfalfa cultivars (two conventional and one low lignin). Plots were established in late November of 2017, but no samples collected during establishment year. During 2019, forage yield plots samples were

obtained after mechanical harvest. Samples will be analyzed for nutrient content and IVTDMD and IVNDFD.

Yield and nutritional composition of conventional and BMR pearl millet with different establishment dates or harvest at different maturity stages.

Trial 1: Two varieties of pearl millet (conventional and BMR) were planted at two different dates in 2018. Plots were harvested 3 times at early heading stage between. Samples were analyses for nutrient content IVTDMD and IVNDFD.

Trial 2 (ongoing): Two varieties of pearl millet, (conventional and BMR), mixed or not mixed with cowpea (Iron and Clay) were planted in 2019. Pear millet were planted in monoculture (25 lbs./acre) or in mixtures with cowpea. Plots were harvested when pearl millet was at boot stage or at heading. Samples will be analyzed for nutrient content IVTDMD and IVNDFD.

Effect of growing crabgrass alone or in mixtures with summer annual legumes on yield, nutritional value, and in vitro digestibility of fresh and ensiled (baleage) summer annuals and the succeeding winter annual crop.

Our hypothesis is that mixing annual legumes with crabgrass will increase forage yield and fiber digestibility, reduce N utilization and improve forage yield of the following winter annual crop. This is an ongoing study. Crabgrass, crabgrass + N (57 kgs/ha after harvest), cowpea, and lablab was planted in monoculture or in mixtures (6.1 x 3.0-m plots) resulting in 7 treatments. After weighing harvested biomass, forages samples were store -20°C. At the lab, samples will be thawed and then chopped using a commercial lettuce cutter. One subsample will be used for nutrient analyses including in vitro IVTDMD and IVNDFD. To simulate the ensiling process, a second subsample will be wilted to 50% DM and placed into polyethylene embossed pouches and sealed anaerobically with vacuum sealer. After 60 d of fermentation, silos will be opened, and samples will be analyzed for nutrient content, pH and volatile fatty acids.

Impacts

At the conclusion of our projects, we expect the following impacts:

- We will have determined the impact of management practices (cutting schedule) on new low lignin alfalfa southeastern conditions.
- We will have determined optimal management strategies to improve yield and quality of conventional and BMR pearl millet.
- We will determine the impact of mixing crabgrass with annual legumes on fresh forage quality and the feasibility of storing the grass-legume mix as silage (baleage).
- We will have determined if management practices (i.e. N fertilization or crop species) should be modified (or not), when cropping crabgrass with annual summer legumes, to not affect crop yield or nutritional quality of the following crop

Publications:

Peer Reviewed

Aguerre, M. J., B. Duval, J. M. Powell, P. A. Vadas, and M. A. Wattiaux. 2019. Effects of feeding a quebracho-chestnut tannin extract on lactating cow performance and nitrogen utilization efficiency. (under review-minor revisions).

Sun, F., M. J. Aguerre, and M. A. Wattiaux. 2019. Starch and dextrose at 2 levels of rumen degradable protein in iso-nitrogenous diets: Effects on lactation performance, ruminal parameters, methane emission, digestibility, and N balance of dairy cows. Journal of Dairy Science 102:1281-1293.

Klopp, R.N., T. M. Hill, F.X. Suarez-Mena, R.L. Schlotterbeck, and **G.J. Lascano. 2019.** 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. *In press*.

Koch, L.E., T.C. Jenkins, W.J. Bridges, B. Koch***, and **G.J. Lascano**. **2019.** Changes in fermentation and animal performance during recovery from classical diet-induced milk fat depression utilizing corn with differing rates of starch degradability. J. Dairy Sci. 102:5079-5093.

Suarez-Mena, F.J., **G.J. Lascano,** S. Hussein, and A.J. Heinrichs**. 2019.** Effect of dry distillers grains with solubles and forage dietary concentration in precision-fed heifer diets: Mineral apparent absorption and retention. Appl. Anim. Sci. 35:169-176.

Abdulrahman A., Batistel F., Abdelmegeid, M., **Lascano, G.J.,** Parys, C. , Helmbrecht, A.,Trevisi, E., and J.J. Loor. **2018**. Maternal supply of methionine during late-pregnancy enhances rate of Holstein calf development in utero and postnatal growth to a greater extent than colostrum source. J. Anim. Sci. Biotech. 9:83-95.

Abstracts

Hussein, S.M., M.X. Toledo, J. Echesabal, S. Twyman, S. Simmons, J. Sinkevitch, G. Loughlin, and **G.J. Lascano. 2019**. Dose response of caffeine on fermentation and nutrient utilization in continuous culture fermenters. J. Dairy Sci. Supl. 2.

Hussein, S.M., M.X. Toledo*, S. Twyman*, O. Thomas*, J. Echesabal, and **G.J. Lascano. 2019**. Screening unsaturated fat sources included to low and high forage diets with different fat dietary concentration using an *in vitro* gas production system. J. Dairy Sci. Supl. 2.

Hussein, S.M., M.X. Toledo*, S. Twyman*, O. Thomas*, and **G.J. Lascano. 2019.** Simulating precision feeding of high concentrate diets with high fat inclusion and different unsaturated fat sources in continuous culture fermenters. J. Dairy Sci. Supl. 2.

Hussein, S.M., S. Simmons*, J. Sinkevitch*, H. Oswald*, G. Loughlin*, and **G.J. Lascano. 2019.** Simulating precision feeding of high and low forage diets with increasing poultry fat inclusion alter fermentation in continuous culture. J. Dairy Sci. Supl. 2.

Anderson, J.L., P. S. Erickson, K.L. Kalscheur, and **G.J. Lascano. 2019.** Strategies to improve efficiency and profitability of heifer raising. J. Dairy Sci. Supl. 2.

Cornell University (Overton)

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Performing Department Department of Animal Science

Non-Technical Summary:

Research conducted at Cornell as part of this project continues to refine our understanding of the nutritional physiology of the transition dairy cow as well as provide field-usable solutions to continue to improve transition cow health and performance. Studies conducted or reported during the reporting period focused on dietary strategies to decrease postpartum hypocalcemia and improve the dietary adaptation to lactation, understanding the role of nutrients in immune cell signaling, and on the evaluation of new biomarkers as potential herd-level diagnostic tools for inflammation and metabolic health. Results were presented at the 2019 ADSA Annual Meeting as well as various University and industry-organized conferences, extension programs, and technical seminars.

Keywords:

Transition cow, health, diagnostics

Goals / Objectives

Objectives

1. Optimize calf and heifer growth and development by improving feeding strategies, management systems, well-being, new technologies, and environmental impacts for productivity and profitability.
2. Optimize dairy cow performance and well-being by improving nutrition, forage utilization, technology, and management.
3. Evaluate whole farm system components and integrate information and technology to improve efficiency, profitability, environmental sustainability and social responsibility.

Project Methods

Our work in this project was focused on Objective 2. Optimize dairy cow performance and well-being by improving nutrition, forage utilization, technology, and management. We utilized a combination of controlled experiments conducted in vivo using dairy cattle at the Cornell University Dairy Research Center, ex vivo approaches to study immune cell function in blood collected from cows at Cornell, and commercial farm-based studies in which dairy cattle on private farms were sampled and cow- and herd-level outcomes evaluated. Our primary controlled experiments focused on the use of a synthetic Zeolite A fed during the prepartum period on postpartum hypocalcemia and performance (Kerwin et al., 2019), the role of branched-chain amino acid supplementation on metabolism and performance of postpartum cows (Leal-Yepes et al., 2019), and the relationships of undigested NDF and physically effective NDF in the postpartum diet with hepatic metabolism and gene expression (LaCount et al., 2019). Ex vivo approaches to study the rule of nutrients in signaling in immune cells were conducted by Mann et al. (2018) and Sipka et al. (2019). We utilized blood samples and data from 72 commercial dairy farms in New York and Vermont to determine the relationships of circulating haptoglobin concentrations with postpartum health disorders and subsequently were able to develop critical thresholds for potential use in cow- and herd-level diagnostic strategies to evaluate inflammation and acute phase response in postpartum cows (Kerwin et al., 2019). Finally, we used a case-control herd-level approach to evaluate the effects of feeding rumen-protected methionine during the postpartum period on performance, health, and metabolism of cows on commercial farms (Gallagher et al., 2019a; 2019b). As part of this work, we also adapted a metabolic health index using circulating blood analytes and were able to establish relationships of this index with performance.

Outputs

Analyzed results from these experiments were incorporated into various presentations during the reporting period for conferences such as Cornell Nutrition Conference, Cornell Feed Dealer Seminar series, the Dairy Nutrition and Management Shortcourse, the Professional Dairy Producers of Wisconsin herd manager workshops and Annual Meeting, and various feed industry-based technical seminars..

Impacts

The research conducted with the synthetic Zeolite A demonstrated that it was effective at decreasing hypocalcemia. The work conducted with evaluation of haptoglobin as a marker provides a key step in the path to establishing this as a potential diagnostic tool at the farm level.

Publications

Peer Reviewed

Kerwin, A. L., C. M. Ryan, B. M. Leno, M. Jakobsen, P. Theilgaard, D. M. Barbano, and T. R. Overton. 2019. Effects of feeding synthetic zeolite A during the prepartum period on

serum mineral concentration, oxidant status, and performance of multiparous Holstein cows. J. Dairy Sci. 102:5191-5207.

Leal-Yepes, F. A., S. Mann, T. R. Overton, C. M. Ryan, L. S. Bristol, G. E. Granados, D. V. Nydam, and J. J. Wakshlag. 2019. Effect of rumen-protected branched-chain amino acid supplementation on production and energy-related metabolites during the first 35 days in milk in Holstein dairy cows. J. Dairy Sci. 102:5657-5672.

Silviera, P.A.S., W. R. Butler, S. E. LaCount, T. R. Overton, C. C. Barros, and A. Schneider. 2019. Polymorphisms in the anti-oxidant paraoxonase-1 (PON1) gene associated with fertility of postpartum dairy cows. Theriogenology. 125:302-309.

Yasui, T., R. M. Ehrhardt, G. R. Bowman, M. Vazquez-Anon, J. D. Richards, C. A. Atwell, and T. R. Overton. 2019. Effects of trace mineral amount and source on aspects of oxidative metabolism and responses to intramammary lipopolysaccharide challenge in midlactation dairy cows. ANIMAL. 13:1000-1008. doi: 10.1017/S1751731118002525

Mann, S., A. Sipka, F. A. Leal-Yepes, D. V. Nydam, T. R. Overton, and J. J. Wakshlag. 2018. Nutrient-sensing kinase signaling in bovine immune cells is altered during the postpartum nutrient deficit: A possible role in transition cow inflammatory response. J. Dairy Sci. 101:9360-9370.

Abstracts

Brown, W. E., M. Garcia, L. K. Mamedova, M. G. Zenobi, C. R. Staples, B. M. Leno, T. R. Overton, B. K. Whitlock, J. A. Daniel, and B. J. Bradford. 2019. Plasma alpha-1-acid glycoprotein is negatively associated with dry matter intake in postpartum dairy cows. J. Dairy Sci. 102(Suppl. 1):395.

Gallagher, K. R., A. L. Kerwin, J. N. Tikofsky, M. M. McCarthy, and T. R. Overton. 2019a. Associations of early lactation rumen-protected methionine supplementation with herd level health and production performance in the northeastern United States. J. Dairy Sci. 102(Suppl. 1):238.

Gallagher, K. R., A. L. Kerwin, J. N. Tikofsky, M. M. McCarthy, and T. R. Overton. 2019b. Rumen-protected methionine supplementation during early lactation and associations with plasma amino acid, metabolite concentrations, and a novel metabolite health index. J. Dairy Sci. 102(Suppl. 1):21.

Kerwin, A. L., D. V. Nydam, W. S. Burhans, S. K. Wall, K. M. Schoenberg, K. L. Perfield, and T. R. Overton. 2019. Haptoglobin critical thresholds for predicting health disorders during the transition period. J. Dairy Sci. 102(Suppl. 1):25.

LaCount, S. E., W. R. Butler, and T. R. Overton. 2019. The effects of varying undigested NDF and physically effective NDF content of fresh cow rations on hepatic metabolism and gene expression in multiparous Holstein cows. J. Dairy Sci. 102(Suppl. 1):225.

Sipka, A., T. Chandler, T. Overton, and S. Mann. 2019. Ex vivo mammalian target of rapamycin (mTOR) pathway activation of bovine immune cell subsets during the transition period. J. Dairy Sci. 102(Suppl. 1):301.

Staffin, A. N., S. E. LaCount, W. R. Butler, and T. R. Overton. 2019. The effects of polymorphisms in growth hormone receptor, insulin-like growth factor-1, and tumor necrosis factor-α genes on hepatic gene expression in postpartum dairy cattle. J. Dairy Sci. 102(Suppl. 1):22

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Extension Publications and others

Kerwin, A., and T. Overton. 2018. Dietary management of subclinical hypocalcemia with zeolite A. Progressive Dairyman. December 2018.

Kerwin, A. L., C. M. Ryan, B. M. Leno, M. Jakobsen, P. Theilgaard, and T. R. Overton. 2018. Prepartum dietary management of hypocalcemia through the use of a synthetic zeolite A. Proceedings, Cornell Nutrition Conference for Feed Manufacturers. Syracuse, NY.

Overton, T. R., and S. E. LaCount. 2018. The importance of fiber as a source of energy during the transition period. Proceedings, Cornell Nutrition Conference for Feed Manufacturers. Syracuse, NY.

University of Idaho (Chahine)

Project Director
Mireille Chahine

Personnel
Taylor Kelley (MS student), Lani Martin (MS student)

Collaborators: Joe Dalton, Mario de Haro Marti, Steve Hines, Rick Norell, Glenn Shewmaker, Hernan Tejeda

Recipient Organization
University of Idaho

Performing Department
Animal and Veterinary Science

Non-Technical Summary:
Two projects conducted in 2018-2019 were the direct result of a collaboration between two NC2042 stations, Virginia Tech and the University of Idaho. Research examined the effect of irrigation on fiber concentration and digestibility of corn plant tissues. Another collaboration between these two entities resulted in developing a set of workshops addressing risk management education topics covering production risk, marketing risk, financial risk and human risk. These educational workshops included subject presentations, on-hands work with spreadsheets, delivery of fact-sheets, and discussions among peers and presenter(s). Multiple research projects were also conducted to examine the effect of feeding betaine on rumen fermentation and microbiome of dairy cows.

Keywords:
Corn silage, fiber digestibility, risk management, betaine

Goals / Objectives

Objectives

1. Optimize calf and heifer growth and development by improving feeding strategies, management systems, well-being, new technologies, and environmental impacts for productivity and profitability.
2. Optimize dairy cow performance and well-being by improving nutrition, forage utilization, technology, and management.
3. Evaluate whole farm system components and integrate information and technology to improve efficiency, profitability, environmental sustainability and social responsibility.

Activities

Effect of irrigation on fiber concentration and digestibility of corn plant tissues. Martin, L. G. Ferreira, C. L. Teets, S. Hines, G. Shewmaker, M. de Haro Marti, and M. Chahine. The objective of this study was to determine the effect of irrigation on neutral detergent fiber (NDF) and lignin (LIG) concentrations and on in vitro apparent dry matter digestibility (IVDMD), and in vitro neutral detergent fiber digestibility (IVNDFD) of stems, leaf-sheaths, and leafblades of corn. Five commercial corn hybrids for silage (one of them showing the brown midrib phenotype) were planted in a split-plot setting within a randomized complete block design (4 replicates). Treatments consisted of a control treatment with furrow irrigation at planting and 3 more times during crop growth (WATERED) and a non-irrigated treatment with furrow irrigation only at planting (NON-WATERED). When the corn was between 1/4 and 3/4 milk-line stage of maturity, 5 plants from each plot were cut by hand, and stems, leaf-sheaths, and leaf-blades from the second phytomer below (LOWER) and the second phytomer above (UPPER) the ear insertion were dissected and frozen for analysis. Tissues were analyzed for NDF concentration, IVDMD, and IVNDFD. Data were analyzed using Proc Mixed of SAS, and the model included the effects of block (random, df = 3), treatment (fixed, df = 1), whole-plot error (random, df = 3), hybrid (fixed, df = 4), treatment by hybrid interaction (fixed, df = 4), and the residual or split-plot error (random, df = 25). WATERED contained lower NDF concentrations (64.6 vs. 67.6% NDF; $P < 0.01$) and greater IVDMD than NON-WATERED plots (56.7 vs. 54.8% IVDMD; $P < 0.05$). IVNDFD tended to be greater for WATERED than for the NON-WATERED plots (51.7 vs. 50.1% IVNDFD; $P < 0.10$). Irrigation did not affect LIG concentration in the cell wall ($P < 0.11$), which averaged 19.9%. UPPER phytomers had a lower NDF concentration (64.4 vs. 67.7%; $P < 0.01$) and a greater IVNDFD than LOWER phytomers (52.8 vs. 49.0%; $P < 0.01$). In conclusion, under the conditions of this study, limited water supply does not affect lignin concentration in the cell wall and does not increase the in vitro digestibility of fiber in corn for silage. The latter observation is contrary to the general industry belief that water-stress increases fiber digestibility in forages.

An observational study of cow contact resistance conditions on commercial dairy farms in Idaho. Norell, R., J. Wilson, M. de Haro Marti, M. Chahine, and A. Ahmadzadeh. The electrical resistance of dairy cows is decreased with wet haircoats, standing on wet flooring, and touching wet metal. We assessed electrical contact conditions on 27 commercial dairies by observing wetness of cow contact areas within cattle housing and the milking parlor plus measured resistance of water from water troughs. Cattle housing on survey farms was 100% open lot (n = 10), 100% freestall (n = 10), or both (n = 7). Herd size ranged from 300 to 4000 cows and parlors were parallel (n = 24) or herringbone (n = 5). Composite water samples were collected from 18 dairies. The electrical resistance of each water sample was measured by inserting a 10 × 10 cm aluminum probe at 2 angles on the water surface (45 and 90 degrees) and at 2 water depths (8.9 and 17.8 cm). Data were analyzed as a 2 × 2 factorial in SAS, blocking on dairy. During our freestall observations, all of the holding corrals, transfer lanes, cow alleyways and crossovers with waterers were wet from urine and feces. Open lots and feed lanes were wet from recent rain or melting snow. Median and range in percentage of wet parlor splash plates, cows touching the splash plate, and wet rear udders during milking were: 48%, 48 to 92%; 54%, 0 to 91%; and 44%, 17 to 93%, respectively. The median percentage of cows touching the splash plate was lower in herringbone (7%) versus parallel parlors (61%) and lower for first-lactation cows (15%)

than mature cows (64%). Wet splash plates and udders were more common from cows housed in open lot pens (median = 72%) during wet conditions versus covered freestalls (median 25%). Measured resistance of water samples ranged from 33 to 110 ohms and were significantly lower ($P < 0.001$) at 45° versus 90° and significantly higher ($P < 0.001$) at a depth of 17.8 cm than at 8.9 cm. In conclusion, the electrical resistance of Idaho dairy cows is decreased during the winter months due to wet conditions. The potential for wet contact of the udder with parlor splash plate varies with cow size, parlor type, and environmental conditions. Water resistance varies widely between locations and should be considered during farm evaluations. per cow, respectively). Overall, our study demonstrated that betaine supplementation affected the total serum FA profile in mid-lactation dairy cows without affecting the milk FA profile. Key Words: lactating dairy cow, dietary betaine, serum fatty acid.

In vitro rumen fermentation characteristics of highgrade crystalline versus low-grade liquid betaine products. Kelley, T., G. Chibisa, P. Rezamand, and M. Chahine, 1University of Idaho, Twin Falls, ID, 2University of Idaho, Moscow, ID. Betaine, a co-product of sugar-beet processing, can be used to feed cattle. Because high-grade betaine (>90% pure; DM basis) is expensive, feed-grade products with lower betaine concentration are typically used in cattle rations. However, there is limited information on the impact of feeding the feed-grade betaine products on rumen fermentation characteristics. Therefore, our objective was to compare in vitro rumen fermentation characteristics of a high-grade betaine (97% purity) to a feed-grade betaine product (32% purity). The Ankom gas production system was used (Ankom Technologies, Macedon, NY) to determine the in vitro fermentation characteristics of both products at the same inclusion level. Three dietary treatments were used: control (CON) with no betaine added, high-grade crystalline betaine (CRYS), and feed-grade liquid betaine (LB50) at 0.50% of diet DM. The study was a completely randomized design and each treatment was added to 2 Ankom modules, which contained 1.5 g of TMR, 15 mL rumen fluid, and 45 mL McDougall's buffer. Two Ankom modules were also used as blank/run. A total of 3 runs were conducted. Data were analyzed using the mixed procedure of SAS. Crystalline betaine had a greater CP content compared with the liquid betaine (72.8 vs 56.7% DM). Total volatile fatty acid production tended to be greater in LB50 vs CRYS (140.23 vs. 109.14 mM respectively, $P = 0.09$) while no differences ($P > 0.1$) were detected in the molar proportions of acetate, propionate, butyrate, isobutyrate, valerate, isovalerate, and caproate, which averaged 49.15 ± 0.81, 29.67 ± 0.69, 13.78 ± 0.51, 1.27 ± 0.04, 3.50 ± 0.12, 2.06 ± 0.09, and 0.58 ± 0.07% respectively. Final pH did not differ ($P = 0.27$) among treatments and averaged 6.20 ± 0.02. Similarly, in vitro true DM digestibility and methane production did not differ ($P \geq 0.15$) among treatments. In summary, the lack of differences in in vitro fermentation characteristics between an expensive high-grade and a lower-grade betaine product suggests a similar feeding value when fed at the same dietary inclusion rate. Key Words: in vitro fermentation, VFA, betaine.

Effect of betaine supplementation on total serum fatty acids profile in mid-lactating Holstein dairy cows. Hung, H. C., C. Y. Tsai, M. Chahine, and P. Rezamand. Betaine is a product of choline oxidation in the body and an ingredient of wheat and sugar beets. Betaine can donate one methyl group to transfer homocysteine into methionine, which is involved in the phosphatidylethanolamine N-methyltransferase (PEMT) pathway. We hypothesized that betaine supplementation affects the serum fatty acids (FA) profile in mid-lactation dairy cows. There were 21 mid-lactation dairy cows assigned to a 3 × 3 Latin square design with 3 periods of 28 d

each and 3 treatments of betaine (0, 100, and 200 g/d). Milk samples collected on d 21 and d 28 and blood samples obtained on d 26 to 28 of each period were used for FA analysis via gas chromatography with flame ionization detector and an Agilent HP-88 column (100 m × 0.25 mm with 0.2-μm film thickness, Agilent Technologies). Individual FA was identified by comparison to the standard mixture Supelco 37 FAME (Supelco, Bellefonte, PA). Data were analyzed using the Proc Mixed of SAS with significance declared at $P \leq 0.05$ and trends at $P \leq 0.1$. Results showed that no change was observed in the content of total serum saturated FA (40.5, 40.4, and 40.3 ± 0.6% for 0, 100, and 200 g betaine, respectively; $P = 0.96$). The total serum monounsaturated FA decreased with betaine supplementation (16.2, 15.2, and 14.9 ± 0.32%, for 0, 100, and 200 g betaine, respectively; $P = 0.01$). Serum FA profile showed a decline in the n-6 to n-3 ratio (6.80, 7.07, and 6.50 ± 0.16%, for 0, 100, and 200 g betaine, respectively; $P = 0.04$). Results showed however, that milk FA profile did not differ among treatments (0, 100, and 200g betaine/d per cow, respectively). Overall, our study demonstrated that betaine supplementation affected the total serum FA profile in mid-lactation dairy cows without affecting the milk FA profile. Key Words: lactating dairy cow, dietary betaine, serum fatty acid

Impacts

We demonstrated that limited water supply does not affect lignin concentration in the cell wall and does not increase the in vitro digestibility of fiber in corn for silage. The latter observation is contrary to the general industry belief that water-stress increases fiber digestibility in forages. Our research also demonstrated lack of differences in in vitro fermentation characteristics between an expensive high-grade and a lower-grade betaine product suggests a similar feeding value when fed at the same dietary inclusion rate.

Publications 2018-2019

Peer Reviewed

Tejeda, H., G. Ferreira, M. Chahine, and M. de Haro-Marti. 2019. Risk assessment and decision-making guidelines for dairy risk Management -- Part I. University of Idaho Extension Bulletin 952.

Tejeda, H., G. Ferreira, M. Chahine, and M. de Haro-Marti. 2019. Risk assessment and decision-making guidelines for dairy risk management -- Part II. University of Idaho Extension Bulletin 953.

Tejeda, H., G. Ferreira, M. Chahine, and M. de Haro-Marti. 2019. Risk assessment and decision-making guidelines for dairy risk management -- Part III. University of Idaho Extension Bulletin 954.

Chahine, M., de Haro-Marti, M., Matuk, C, Aris, A., Campbell, J. and A. Bach. 2019. Effects of spray-dried plasma protein in diets of early lactation dairy cows on health, milking and reproductive performance. Animal Feed Science and Technology, Vol. 257. https://doi.org/10.1016/j.anifeedsci.2019.114266

Bouajila, A., Ammar, H., Chahine, M., Khouja. M., Hamdi, Z., Khechini, J., Zeidan, A., Salem, M., Ghorbel, A., and Lopez, S. 2019. Changes in phytase activity, phosphorus and phytate contents during grain germination of barley (Hordeum vulgare L.) cultivars. Agroforest Syst, https://doi.org/10.1007/s10457-019-00443-y

Dalton, J. C., D. A. Moore, and M. Chahine. 2019. Genómica en humanos y animales: Un vasto panorama. Washington State University Veterinary Medicine Extension. Available at: https://s3.wp.wsu.edu/uploads/sites/2147/2019/02/The-Big-Picture-Genomics-Humans-and-Animals-Final-Spanish.pdf

Dalton, J. C., D. A. Moore, and M. Chahine. 2019. La selección genómica ha cambiado la manera de seleccionar los toros en la ganadería lechera. Washington State University Veterinary Medicine Extension. Available at: https://s3.wp.wsu.edu/uploads/sites/2147/2019/02/Genomic-Selection-Has-Changed-Dairy-Sire-Selection-Final-Spanish.pdf

Abstracts

Martin, L., G. Ferreira, C. L. Teets, S. Hines, G. Shewmaker, M. de Haro Marti, and M. Chahine. 2019. Effect of irrigation on fiber concentration and digestibility of corn plant tissues. J. Dairy Sci. 102: E-supplement 1.

Norell, R., J. Wilson, M. de Haro Marti, M. Chahine, and A. Ahmadzadeh. 2019. An observational study of cow contact resistance conditions on commercial dairy farms in Idaho. J. Dairy Sci. 102: E-supplement 1.

Kelley, T., G. Chibisa, P. Rezamand, and M. Chahine. 2019. In vitro rumen fermentation characteristics of highgrade crystalline versus low-grade liquid betaine products. J. Dairy Sci. 102: E-supplement 1.

Hung, H. C., C. Y. Tsai, M. Chahine, and P. Rezamand. 2019. Effect of betaine supplementation on total serum fatty acids profile in mid-lactating Holstein dairy cows. J. Dairy Sci. 102: E-supplement 1.

University of Illinois at Urbana-Champaign (Cardoso)

Personnel: Felipe (Phil) Cardoso (Project Leader), Russell Pate (PhD student), Kelly Ryan (MS student), M. Ines Rivelli (PhD student), Taylor Damery (MS student), Maegan Weatherly (PhD student), Laura Fehlberg (PhD student), Anne Rosi (PhD student), and Fabiana Cardoso (PhD student).

Collaborators: James K. Drackley, J. Loor, and D. W. Shike, University of Illinois; Leo Timms, Iowa State University; Lance Baumgard, Iowa State University; M. Akins, University of Wisconsin-Madison; Ken Kauscher, USDA Forage Center; Rodrigo Almeida, UFPR, Brazil; and M. Neves, UFLA, Brazil.

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:

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

Accomplishments:

Outputs: *Under objective 2.*

Effects of rumen-protected methionine fed during a heat stress challenge on physiological and production parameters of lactating Holstein cows. Abstract at ADSA 2019; Cincinnati, OH.

R. T. Pate,* D. Luchini,† and F. C. Cardoso*
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Milk yield, content and composition are altered by heat stress (HS), however, rumen-protected methionine feeding may ameliorate the effects of HS. Thirty-two multiparous, lactating Holstein cows [DIM (184±59); body surface area (5.84±0.34m2)] were randomly assigned to 1 of 2 environmental treatment groups, and 1 of 2 dietary treatments [TMR with rumen-protected methionine (RPM; Smartamine M; Adisseo Inc., Antony, France; 0.105% DM of TMR as top dress) or TMR without RPM (CON)] in a crossover design. The study was divided into 2 periods with 2 phases per period. In phase 1 (9d), all cows were in thermoneutral conditions (TN; THI=60±3) and fed ad libitum. In phase 2 (9d), group 1 (n=16) was exposed to HS using electric heat blankets (THI=89±3). Group 2 (n=16) remained in TN (THI=61±4) but was pair-fed

(PFTN) to HS counterparts. After a 21d washout period, the study was repeated (period 2). Environmental treatments were inverted relative phase 2 in period 1, while the dietary treatments remained the same. Cows were milked 3× per d and samples were taken on d 1, 5, and 9 of each phase. Vaginal temperature was measured every 10 min, and respiration rate recorded once daily. Paired difference values were calculated for each cow for each period based on the difference between phase 1 baseline values and phase 2 values for each variable. Statistical analysis was performed on paired difference values using MIXED procedure of SAS. Cows in HS had greater ($P<0.001$ and $P<0.001$, respectively) increase in vaginal temperature and respiration rate (+0.2°C and +13.7 breaths/min respectively) compared to cows in PFTN (0.0°C and -1.6 breaths/min, respectively). Cows in PFTN had greater ($P=0.001$ and $P<0.001$, respectively) decrease in DMI and milk yield (-3.9 kg/d and -2.6 kg/d, respectively) compared to cows in HS (-3.2 kg/d and -0.9 kg/d, respectively). Cows in CON had greater ($P=0.04$) decrease in milk protein proportion (%) for PFTN (-0.10%) and HS (-0.06%) compared to cows in RPM for PFTN (0.00%) and HS (-0.02%). In conclusion, HS altered physiological and production parameters, while RPM aided milk fat and protein content during HS.

Evaluation of supplemental autolyzed yeast on production parameters of Holstein cows fed a high starch diet. ADSA 2019; Cincinnati, OH.

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The addition of autolyzed yeast (AY) has proven to have beneficial effects on high starch diets resulting to positive implications on production parameters. This study postulated that the addition of AY (Saccharomyces cerevisiae) supplementation in a high starch lactation diet would improve milk production. Fifteen rumen-cannulated Holstein cows were assigned to 1 of 5 treatments in a replicated 5 × 5 Latin square design balanced to measure carryover effects. Treatments were: low starch diet without AY (LS0; control), high starch diet without AY (HS0), high starch diet with either 15 g (HS15), 30 g (HS30), or 45 g (HS45) of AY supplementation. The period of 21 days was divided into the adaptation phase (d 1 to 14) and a measurement phase (d 15 to 21). Cows were milked 3 times daily at 0400, 1200, and 1930 h. Milk weights were recorded at every milking during the measurement phase and milk samples were obtained at each milking on d 15 and 20 of each period. Data were analyzed using the MIXED procedure of SAS. Cows in HS0 had increased DMI (24.91 vs. 19.93 kg/d; $P < 0.0001$), BW (689 vs. 665 kg; $P = 0.003$), milk yield (34.51 vs. 30.50 kg/d; $P = 0.0006$), and ECM (34.39 vs. 31.27 kg/d; $P = 0.03$) compared to cows in LS0. Cows in HS0 had greater true protein (1.10 vs. 0.94 kg/d; $P = 0.0008$), casein (0.43 vs. 0.32 kg/d; $P = 0.002$), and lactose (1.63 vs. 1.41 kg/d; $P = 0.004$) yields compared to cows in LS0. In relation to the HS0 treatment, cows in LS0 had greater fat concentration (3.89 vs. 3.56 %; $P = 0.007$), and MUN (14.37 vs. 13.56 mg/dL; $P = 0.09$). The LS0 treatment had greater FCM/DMI (1.62 vs. 1.32; $P = 0.0003$), ECM/DMI (1.64 vs. 1.32; $P <0.0001$), and milk/DMI (1.56 vs. 1.38; $P = 0.008$) efficiencies when compared to cows in HS0. Cows in HS45 had increased DMI (24.91 vs. 25.59 kg/d; $P = 0.02$) than cows in HS0. Cows in HS15 tended to improve 3.5% FCM/DMI (1.42 vs. 1.32; $P = 0.09$), and ECM/DMI (1.41 vs.

1.32; P = 0.07) efficiencies when compared to cows in HS0. As expected, cows receiving a high starch diet had increased DMI, ECM, and milk yield than cows in the low starch diet. In conclusion, adding AY improved DMI and production efficiencies.

Evaluation of supplemental autolyzed yeast on ruminal pH, fecal pH, and VFA response from Holstein cows fed a high starch diet. ADSA 2019; Cincinnati, OH.

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High starch diets fed an extended period of time are known to reduce rumen pH, and cause shifts in the VFA profile, resulting in potential health problems. The aim of this study was to investigate if the addition of autolyzed yeast (AY; Saccharomyces cerevisiae) supplementation in a high starch lactation diet would improve rumen pH, fecal pH, and shifts in VFA response. Fifteen rumen-cannulated Holstein cows were assigned to 1 of 5 treatments in a replicated 5 × 5 Latin square design balanced to measure carryover effects. Treatments were: low starch diet without AY (LS0; control), high starch diet without AY (HS0), high starch diet with either 15 g (HS15), 30 g (HS30), or 45 g (HS45) of AY supplementation. The period of 21 days was divided into the adaptation phase (d 1 to 14) and a measurement phase (d 15 to 21). Rumen fluid was collected via rumen cannula on d 15 and 16 in relation to feeding at 1400 h (time point 0). Rumen samples were extracted at 0, 4, 8, 12, 16, 20, and 24 h relative to feeding. Cows in HS0 experienced lower ruminal pH (6.10 vs. 6.38; P < 0.0001), nadir pH (5.53 vs. 5.74; P < 0.0001), and fecal pH (6.71 vs. 6.95; P = 0.042) compared to LS0. The addition of AY increased rumen pH (P = 0.04), and nadir pH (P = 0.009), compared to HS0 with no effect on fecal pH. Supplementing AY reduced individual VFA proportions of acetate, isobutyrate, and isovalerate (P = 0.02; P = 0.0004 and P = 0.002, respectively) when compared to cows in HS0. Total VFA proportion was greatest (136.71 mmol/L; P = 0.0005) in cows fed HS0 compared to LS0. Total VFA proportions were greater for propionate (23.87 vs. 20.75 %; P < 0.0001) and valerate (1.50 vs. 1.35 %; P = 0.0001) for cows in HS0 than LS0. Supplementing AY positively increased total propionate proportion (P = 0.002) and negatively decreased total acetate (P < 0.0001), isobutyrate, (P = 0.0003), and isovalerate (P = 0.01) when compared to HS0. Total VFA acetate (65.51 vs. 62.41 %; P < 0.0001), isobutyrate (0.85 vs. 0.78 %; P = 0.0001), and isovalerate (0.63 vs. 0.60 %; P = 0.02) were greater in LS0 treatment compared to HS0. In conclusion, these results confirm the addition of AY aids in increased rumen pH values and shifts in VFA response.

The effect of casein genetic variants and diet composition on Holstein milk proteome. ADSA 2019; Cincinnati, OH.

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1University of Illinois, Urbana, Illinois.

Bovine milk casein (CN) account for about 80% of the total proteins in milk. Genes encoding bovine CN are in chromosome 6. The most common alleles in dairy cattle are A1 and A2, being the former one a genetic variation of A2 that happened thousands of years ago and affected

European cattle origins. Variants A1 and A2 apparently occurs at the same allele frequencies in Holstein cows. Dairy milk protein profile can be influenced by many factors as breed, lactation stage, mastitis, and diet composition. The way these variants affect milk protein composition is off special interest due to their impact on dairy products processability and functionality, and their impact on human health. A database from 13 experiments completed at the University of Illinois (Urbana-Champaign) from 2016 to 2018 was developed. A total of 142 cows (117 multiparous and 25 primiparous) was included in the analyses. Cows β-CN genetic evaluation (i.e.; A1_A1, A1_A2; and A2_A2) for 128 cows was performed (Clarifide. Zoetis, Kalamazoo, MI). Treatments were as follow: cows A1_A1, cows A2_A2, and cows A1_A2. Parity was dichotomized as cows starting first lactation in one group (LAG1), cows starting second or third lactation in a second group (LAG2), and cows in the fourth-or-greater lactation in a fourth group (LAG3). Data were analyzed using the MIXED procedure of SAS, using two orthogonal contrasts. Contrast 1 (CONT1): A1_A1 compared with A2_A2 and contrast 2 (CONT2): A1_A1 compared to the average of A2_A2 and A1_A2. Milk yield was greater for cows A1_A1 than cows A2_A2 and A1_A2 (35.63 vs 34.24 ± 0.63 kg/d; P = 0.03, CONT2). There were no milk protein yield differences among treatments (P > 0.1, CONT1 and CONT2). There were no milk casein as a percentage of protein differences among treatments (P > 0.1, CONT1 and CONT2). Milk lactose yield was greater for cows A1_A1 than cows A2_A2 and A1_A2 (1.69 vs 1.61± 0.04 kg/d; P = 0.02, CONT2). Cows A1_A1 tended to have greater milk lactose yield than cows A2_A2 (1.69 vs 1.62± 0.04 kg/d; P = 0.06, CONT1). In conclusion, cows homozygotes A1_A1 had similar milk protein yield and milk casein yield than homozygotes A2_A2 and heterozygotes A1_A2. Cow homozygotes A1_A1 had the greatest milk yield and lactose yield.

Activities

Producer interactions (extension activities)

1. California Animal Nutrition Conference and Technical Symposium. Title “Effects of Altering Energy Balance and Feed Intake on Reproductive Performance in Lactating Cows”. Approximately 180 participants. May 2 – 3, 2018, Fresno, CA.
2. Mid-South Ruminant Nutrition Conference. Title “Effect of altering energy and amino acid nutrition on health and reproductive performance of dairy cows”. Approximately 190 participants. August 8 – 9, 2018, Grapevine, TX.
3. California Animal Nutrition Conference and Technical Symposium. Title “Using amino acid nutrition to improve productive, health, and reproductive performance in dairy cows”. Approximately 180 participants. May 8 – 9, 2019, Fresno, CA.
4. Zenakuren Dairy Cooperative Annual Seminar: Title: “Nutrition management to optimize health and fertility in dairy cows”. Approximately 1,200 participants. February 5-20, 2018, Kumamoto, Nagoya, Okayama, Obihiro, Sendai, Tokyo, Japan.
5. Kemin Eastern Europe Annual Seminar: Connecting Dots of Amino Acid Nutrition – Nutrition to Maximize the Farm Efficiency. Title: “Feeding amino acids for improved reproductive performance” Approximately 120 participants. March 6, 2018, Turzno, Poland; and approximately 90 participants. March 7, 2018, Geldern, Germany.
6. Adisseo TOP dairies Annual seminar. Title: “Feeding amino acids for improved reproductive performance and health” Approximately 25 participants. June 8, 2018, Paris, France.

7. Total Dairy Seminar 2018. Titles: “Are All Clays Created Equal? Clay Utilization In Diets For Dairy Cows” and “Pre-And Post-Partum Nutritional Management To Optimize Energy Balance And Fertility In Dairy Cows”. Approximately 600 participants. July 4 and 5, 2018, Stratford-upon-Avon, England.
8. 28º Congresso Brasileiro de Zootecnia and V Formuleite at Universidade Federal de Lavras (UFLA). Title: “Energy, fiber, and starch for dairy cows around calving”. Approximately 800 participants. August 27-30, 2018, Goiania, GO, Brazil.
9. Biomin Advanced Training Camp Ruminant. Titles: “Are All Clays Created Equal? Clay Utilization In Diets For Dairy Cows” and “Pre-And Post-Partum Nutritional Management To Optimize Energy Balance And Fertility In Dairy Cows”. Approximately 100 participants. September 18-20, 2018, Krems, Austria.
10. Total Transition Technical Conference. Title: “Metabolizable Protein & Amino Acids in the Transition Period”. Approximately 400 participants. November 15, 2018, Manchester, England.
11. Western Canadian Dairy Seminar. Titles: “Strategies to Alleviate Aflatoxin Deleterious Effects on Performance, Inflammation, and Oxidative Stress in Dairy Cows” and “Impact of Nutritional Strategies”. Approximately 925 participants. March 5 – 8, 2019, Red Deer, AB, Canada.
12. Paraná Federal University (UFPR) seminar on recent topics in dairy nutrition. Title: “Impact of Amino Acid Nutrition on Fertility of Dairy Cows”. Approximately 60 participants. April 9, 2019, Curitiba, PR, Brazil.
13. Simpósio Leite Integral. Title: “Impact of the Right Diet on Performance, Health, and Fertility in Dairy Cows”. Approximately 1,025 participants. April 10, 2019, Curitiba, PR, Brazil.
14. ExpoLeche GILSA Aguascalientes. Title: “Impact of Amino Acid Nutrition on Fertility of Dairy Cows”. Approximately 400 participants. May 10, 2019, Aguascalientes, MX.

Milestones:

1. Dairy Focus Lab. 2012.University of Illinois, Department of Animal Sciences. Extension. Dr. Cardoso developed this web site and serves as editor or author for posted materials. This comprehensive dairy focused site is accessible through a unique link and is linked to the Department of Animal Sciences and University of Illinois Extension. http://www.dairyfocus.illinois.edu
2. The web site provides educational materials in the areas of dairy nutrition, reproduction , and management; such as:
    a. Dairy Efficiency Calculator part of the “Dairy Focus Toolbox” (i.e. income over feed cost). Excel file is available on-line for download by users. More than 352 downloads (dairy farmers, veterinarians, nutritionists, professors, and students) from more than 49 different countries.
    b. Dairy Somatic Cell Count Calculator part of the “Dairy Focus Toolbox” (i.e. mastitis prevention). Excel file is available on-line for download by users. More than 488 downloads (dairy farmers, veterinarians, nutritionists, professors, and students) from more than 51 different countries.

c. Dairy Focus Newsletter. More than 93 subscribers (dairy farmers, veterinarians, nutritionists, professors, and students) from more than 19 different countries.
d. You tube videos (20) that collectively have had more than 18,700 visualizations in more than 25 different countries.
e. Podcasts (3) that were broadcasted through web based radio stations.
f. Social media (Facebook) with more than 531 people connected (likes) from more than 45 different countries.
g. "Press mentions" section with more than 40 articles that were reported by the press as a result of formal and informal interviews to Dr. Cardoso.
h. Section with information in Spanish for users with no English skills.

Publications

1) Pate, R.T., D.M. Paulus Compart, and **F.C. Cardoso**. (2018). Aluminosilicate clay improves production responses and reduces inflammation during an aflatoxin challenge in lactating Holstein cows. Journal of Dairy Science. 101:11421-11434.

2) Dhoblea, A.S., K.T. Ryan, P. Lahiria, M. Chenc, X. Panga, **F. C. Cardoso**, and K. D. Bhalerao (2019). Cytometric fingerprinting and machine learning (CFML): A novel label-free, objective method for routine mastitis screening. Comp. and Elect. In Agric. 162:505-513.

3) Hollis, M.E., R.T. Pate, S. Mideros, G.M. Fellows, M. Akins, M.R. Murphy, and **F.C. Cardoso**. (2019). Foliar fungicide application effects on whole plant BMR and floury corn varieties, and whole plant corn silage composition. Animal Feed Science Technology. *In-Print*.

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

University of Kentucky (Costa)

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: Joao HC Costa
3. Personnel: Jessica Ferrel (Research Coordinator), Melissa Cornett (PhD student), Emily Rice (PhD Student), Tanya France (MSc Student), Gustavo Mazon (PhD Student Student), and Megan Woodrum (MSc Student).

C. Objective of the Project:

The long-term goal of this research program is to create new management strategies based on the use of precision dairy technologies, especially related to the early detection of diseases, the use of multi-teared algorithms, and the development, application and validation of new technologies. Also, a secondary objective for the period is the investigation of early sign of disease in calves and investigation of the effects of feed additive in calf fed high allowance of milk.

D. WORK PROGRESS AND PRINCIPAL ACCOMPLISHMENTS:

This research done in the last period provides new insight into the use of precision dairy technologies, the examination of feeding behavior and activity development of calves, and the potential for compost bedded pack barns.
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E. PUBLICATIONS:

Peer-reviewed:

1. Costa, J.H.C.,† , Cantor, M.C.‡, and H.W. Neave. In press. Invited Review: Key animal welfare issues in commercially-raised dairy calves: social environment, nutrition, and painful procedures. Can. J. Anim. Sci.
2. Quinn, J. ‡, D.T. Nolan, P.D. Krawczel, C.S. Petersson-Wolfe, G.M. Pighetti, A.E. Stone, S.H. Ward, J.M. Bewley, and Costa, J. H. C†. In press. Comparing dairy farm milk production, milk quality, and reproductive performance among United States regions using summer to winter ratios. J. Dairy Sci.
3. Hawkins, A. ‡, Burdine, K., D. Amaral-Phillips, and J. H. C. Costa†. 2019. An Economic Analysis of the Costs Associated with Pre-Weaning Management Strategies for Dairy Heifers. Animals 9 (7), 471.

4. Mullins, I. L. ‡, C. M. Truman‡, J. M. Bewley, and J. H. C. Costa†. 2019. Validation of an automated body condition scoring camera system for dairy cattle. Animals. 9 (6), 287.
5. Cantor, M. C. ‡, A. L. Stanton, D. K. Combs, and J. H. C. Costa. 2019. Impacts of using a milk feeding strategy and feeding a lactic acid based probiotic on growth, behavior, and rumen development in dairy calves fed using an automated feeding system. J. Anim. Sci. 97 (3), 1052-1065.
6. Cantor, M.C.‡, H.W. Neave, and J.H.C. Costa†. 2019. Invited Review: Current perspectives on the short- and long-term effects of conventional dairy calf raising systems: a comparison with the natural environment. Tranl. AS. 3 (1), 549-563.
7. Grinter, L.N.‡, M. R. Campler, and J.H.C. Costa†. 2019. TECHNICAL NOTE: Validation of a behavior-monitoring collar's precision and accuracy to measure rumination, feeding, and resting time of lactating dairy cattle. J. Dairy Sci. 102 (4), 3487-3494.
8. Bran, J. A., J. H. C. Costa, M. A. G. von Keyserlingk, and M. J. Hötzel. In Review. Factors associated with lameness prevalence in lactating cows housed in freestall and compost-bedded pack dairy farms in southern Brazil. Prev. Vet. Med.
9. Cantor, M. C. ‡, J. H. C. Costa, and J. M. Bewley. 2018. Impact of observed and controlled water intake on reticulorumen temperature in lactating dairy cattle. Animals. 8(11): 194
10. Dolecheck, K. A., Overton, M. W., Mark, T. B., & Bewley, J. M. (2019). Use of a stochastic simulation model to estimate the cost per case of digital dermatitis, sole ulcer, and white line disease by parity group and incidence timing. Journal of dairy science, 102(1), 715-730.

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

Book Chapters:

11. Costa, J. H. C., M. C. Cantor, H. W. Neave. (2018). Bovine diet. In: J. Vonk, T. K. Shackelford (eds.), Encyclopedia of Animal Cognition and Behavior. Springer International Publishing - Springer Nature 2018. (doi.org/10.1007/978-3-319-47829-6_812-1).

12. Costa, J. H. C., M. C. Cantor, H. W. Neave. (2018). Bovine life history. In: J. Vonk, T. K. Shackelford (eds.), Encyclopedia of Animal Cognition and Behavior. Springer International Publishing - Springer Nature 2018. (doi:10.1007/978-3-319-47829-6_837-1).

Peer-reviewed Extension Articles

13. 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).

14. 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).

15. 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).

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

Our research station research in the last year provided new insight into the utility of precision technology utilized on dairy farm, investigated the economics of dairy calf raising and benchmarking tools at the farm level. Decision support tools will help dairy farmers understand decision economics and make more informed decisions toward improved profitability. Also, a major objective of our research is the development of new housing systems and nutritional management to dairy calves.

Louisiana State University (Williams)

Personnel: Cathleen C. Williams (Project Leader).

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.

Accomplishments:

Outputs:

Under objective 1.

The objective of this experiment is to assess the use of glucose responses to insulin injections as a means to develop a method of measuring insulin sensitivity in neonatal dairy calves.

Six male Holstein calves obtained from the LSU AgCenter Southeast Station will be maintained at the LSU Central Stations Research Farm. Calves will be housed in individual calf hutches and fed milk replacer (Land O'Lakes, 22% CP, 15% fat) according to manufacturer recommendations (1.5 pounds milk powder plus 4 quarts water, divided into 2 feedings daily). Milk replacer will be reduced to one feeding per day (0.75 pounds milk powder and 2 quarts water) on day 42, with weaning on day 49. Calf starter (Purina Amplicalf) and water will be offered free choice. At 3, 6 and 9 weeks of age, insulin tolerance tests will be conducted at 0700 hour. Calves will be fasted overnight and for the duration of the test. Insulin solutions (15 mU/kg BW, 30 mU/kg BW or 60 mU/kg BW) will be infused through a jugular catheter at time 0. Blood will be collected at -10 and 0 minutes pre-insulin infusion and 10, 20, 30, 40, 50, 60, 90, and 120 minutes post- insulin infusion. Blood will immediately be tested in duplicate for glucose concentrations using the Abbot Precision Xtra ™ meter. Previous research indicates that glucometers are precise for use in monitoring changes in blood glucose in dairy cattle (Williams et al., 2004). The percentage decline in glucose concentrations will be calculated for all injections and plotted against the natural log (ln) of the insulin dose for each calf. Linear regression analysis will be used to calculate the regression equation for each calf, and the ln of the dose of insulin resulting in a 50% decline in glucose concentration [ln(ED50)] will be estimated from that equation. ED50 will be calculated by taking the antilog of ln(ED50) as previously described by Caltabilota et al. (2010), and these values will be used to determine which insulin dose can be used to best predict insulin sensitivity in young calves.

Key Words: calves, insulin, glucose

Caltabilota, T.J., L.R. Earl, D.L. Thompson, S.E. Clavier, and P.B. Mitcham. 2010. Hyperleptinemia in mares and geldings: Assessment of insulin sensitivity from glucose responses to insulin infusion. J. Anim. Sci. 88:2940-2949.

Williams, C.C., A.M. Ponson, C.C. Stanley, H.G. Bateman, II, P.T. Richardel, and D.T. Gantt. 2004. Accuracy and precision of commercially available glucometers for use in dairy cattle. J. Dairy Sci. 87 (Suppl. 1): 197.

Impacts:
Experiment is currently in progress

Publications:
Abstract will be presented at ADSA in June, 2020

University of Minnesota (Heins)

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 precision technologies in grazing dairy cattle, leading to improved cattle productivity and wellbeing. Other projects investigating feeding, resting and social behavior of cows and dairy calves showed that monitoring of these behaviors can help improve postpartum cow health.

Outputs University of Minnesota research results were presented at ADSA meetings in Cincinnati, Precisions Dairy Conferences in Rochester, MN and Cork, Ireland, and various conferences in the US.

Activities

Growth, health, and economics of dairy calves fed organic milk replacer versus whole milk in an automated feeding system. The objective of this study was to determine growth, health, and profitability of organic dairy calves fed an organic milk replacer (MR) versus pasteurized whole milk (WM) in an automated group feeding system. The study was conducted at the University of Minnesota West Central Research and Outreach Center's, Morris, MN, organic dairy. Eighty-one Holstein and crossbred calves were assigned to feeding groups by birth order during two calving seasons from March to July 2018 and from September to December 2018. Calves were introduced to the Holm & Laue HL100 Programmable Calf Feeder (Holm & Laue GmbH & Co KG, Westerronfeld, Germany) at 5 d and were allowed to drink up to 8 L/d at the maximum allowance. Calves were weaned from the automated feeder at 56 d. Data were analyzed using PROC MIXED of SAS. Independent variables for analyses were the fixed effects of breed group, season of birth, treatment group, the interaction of season and treatment group, along with pen as a random effect. No differences ($P < 0.05$) were found between MR or WM groups for average daily gain, weaning weight, hip height, and heart girth. The WM calves had shorter ($P < 0.05$) feeding station visit durations (2.44 min) than MR calves (3.01 min), slower ($P < 0.05$) consumption rates (1.85 L/min) than MR calves (2.48 L/min), and higher ($P < 0.05$) consumption amounts (1.52 L/visit) than MR calves (1.32 L/visit). On a daily basis, WM calves had more unrewarded visits to the feeding station (16.07) than MR calves (12.07), fewer unfulfilled visits (3.02 visits) than MR calves (10.34), and fewer fulfilled visits (3.73) than MR calves (5.05). Drinking speeds of WM calves were higher ($P < 0.05$) (1,301.4 mL/min) than the MR calves (581.0 mL/min). The MR calves had higher ($P < 0.05$) fecal scores than WM calves. The cost per kg of gain for MR ($8.82/kg) calves was ($P < 0.05$) higher compared to the WM ($6.35/kg) calves. The results from this study indicate that there may be both health and economic advantages to feeding organic dairy calves whole milk during the pre-weaning period.

Validation of an ear tag for grazing behavior in Minnesota and Ireland. The objective of the study was to validate the ear tag (SMARTBOW GmbH, Weibern, Austria) for grazing behavior. The SMARTBOW ear tag includes an acceleration sensor, a radio chip, and temperature sensor for calibration. SMARTBOW can monitor estrus detection and rumination by acceleration data from ear and head movements. To validate SMARTBOW, a halter system (Rumiwatch, Itin and

Hoch GmbH, Liestal, Switzerland) was used. The halter is comprised of a 3 axis accelerometer that records acceleration patterns by a noseband pressure sensor and detects jaw movements according to chewing activities. The study was conducted at the University of Minnesota grazing dairy in Morris, Minnesota, USA and the Teagasc, Animal & Grassland Research Centre in Ireland. During May and June of 2017, SMARTBOW ear tags were attached to grazing cows and three observers visually recorded behaviors for a total of 90 hours in Minnesota. Observational data from Minnesota and additional data from Ireland were used to develop a grazing algorithm. During September of 2018, data were collected by SMARTBOW and Rumiwatch with 12 crossbred cows in Minnesota (n= 248 hours) and 10 Holstein Friesian cows in Ireland (n= 248 hours). A 2-sided paired t-test compared the percentage of time recorded for grazing behaviors and Pearson correlations (PROC CORR of SAS) evaluated associations between SMARTBOW and Rumiwatch. For total recorded grazing time in Minnesota, the percentage of time recorded by SMARTBOW was 37.0% (CI 32.1 to 42.0) and by Rumiwatch was 40.5% (CI 35.5 to 45.6). For total recorded grazing time in Ireland, the percentage of time recorded by SMARTBOW was 35.4% (CI 30.6 to 40.2) and by Rumiwatch was 36.9% (CI 32.1 to 41.8). SMARTBOW and Rumiwatch agreed strongly for monitoring grazing in Minnesota ($r=0.96$; CI 0.94-0.97; $P < 0.01$) and in Ireland ($r=0.92$; CI 0.90-0.94; $P < 0.01$). The results suggest that there is great potential for SMARTBOW to be utilized in pasture-based dairy production systems to support farm management decision making.

Validation of the RumiWatchSystem to monitor feeding and locomotive behaviors in a grazing dairy herd. The objective of the study was to validate a halter and pedometer for monitoring feeding and locomotive behaviors. The study was conducted at the University of Minnesota grazing dairy in Morris, Minnesota from May to June 2018. Lactating crossbred dairy cows (n = 12) were offered pasture for 22 hours per day during the study. The RumiWatchSystem (Rumiwatch, Itin and Hoch GmbH, Liestal, Switzerland) classified data with a halter as ruminating, eating, drinking and other, and classified data with a pedometer as standing, lying and walking behaviors. In addition, the halter classified jaw movements as grazing bites or rumination chews. Observational data were recorded on Samsung tablets using the Pocket observer app (The Observer XT, Version 14.0, Noldus Information Technology, Leesburg, VA). Agreement was determined between visual observation and the halter and pedometer for 144 hours of feeding and locomotive behaviors. Additionally, grazing bites and rumination chews during 1,205 minutes were evaluated between direct visual observation and the halter. Pearson correlations and concordance correlation coefficient (PROC CORR of SAS), bias correction factors (Cb), location shift (V) and scale shift (μ) (epiR package of R software) evaluated associations between direct visual observations and the halter and pedometer. Correlations between visual observations and the halter ($P < 0.01$) were 0.84 for ruminating, 0.76 for eating, 0.39 for drinking, and 0.57 for other behaviors. Correlations between visual observations and the pedometer ($P < 0.01$) were 0.83 for standing, 0.91 for lying, and 0.38 for walking behaviors. The correlations for grazing bites and rumination chews were 0.46 ($P < 0.01$) and -0.04 ($P = 0.79$), respectively. For grazing bites and rumination chews analyzed together, the correlation was 0.68 ($P < 0.01$). The results suggest that the RumiWatchSystem may accurately monitor rumination and eating, as well as standing and lying behaviors in a grazing system. Behaviors such as drinking and walking were seldom observed and may be difficult to accurately monitor in grazing dairy cattle.

Are fly avoidance behaviors of dairy cows housed on pasture influenced by the use of mesh fly leggings? The objective of this study was to evaluate the effects of mesh fly leggings (Shoofly Leggins; Stone Manufacturing & Supply, Kansas City, MO) on number of flies and fly avoidance behaviors of pastured dairy cows. The study was conducted at the University of Minnesota West Central Research and Outreach Center (Morris, MN, USA) from June to July 2017. In this replicated crossover design study, dairy cows housed on pasture (n = 80) were randomly assigned to 1 of 2 treatment groups: leggings (on all legs) and control (no leggings). Cows were exposed to their treatment for a two-week period, then switched treatments every period for a total of 4 periods (2 replicates per treatment). Counts for face, horn, and stable flies were recorded on all cows twice daily (0930 to 1230 and 1330 to 1630), 3 times per week. A random subset of 40 focal cows was observed in 5-minute intervals for frequency of foot stomps, head tosses, skin twitches, and tail swishes. Period means were used for the analysis using PROC GLIMMIX of SAS. Poisson models were built for fly count data with fixed effects of treatment, time of day, treatment and time of day interaction, period within replicate, replicate, and order of treatment, and a random effect of cow. Head toss, skin twitch, and tail swish behaviors were similar between treatment groups and time of day. Leg stomps were greater ($P < 0.001$) for the control group than the leggings group (mean ± SE; 2.8 and 2.1 ± 0.3 per observation, respectively), and leg stomps were greater ($P < 0.001$) in the afternoon than in the morning (2.8 and 2.1 ± 0.3 per observation, respectively). The number of stable flies was a predictor ($P < 0.0001$) of all observed behaviors and the number of horn flies was a predictor ($P < 0.05$) of head toss, skin twitch, and tail swish behaviors. The number of stable flies on cows was greater ($P < 0.001$) in the afternoon compared to the morning (20.6 ± 0.8 and 15.0 ± 0.6 per cow, respectively). The results of this study indicate that flies cause fly avoidance behaviors in cows regardless of the use of leggings. However, leggings effectively reduce leg stomps and may offer some relief to dairy cows on pasture.

Electrical energy consumption in four commercial Midwest dairy barns. Consumers are demanding reduced carbon emissions and increased sustainability within food production systems. However, fossil energy consumption data within dairy production are scarce. Therefore, the objective of this study was to measure electricity use to determine specific areas of high consumption in four commercial dairy farms. Data were collected from freestall barns representative of typical Midwest dairies and located in west central Minnesota: one 9,500 head, cross-ventilated barn with a rotary parlor (A), one 300 head, naturally-ventilated barn with stirring fans and an automatic milking system (B), one 200 head, naturally-ventilated barn with stirring fans and a parabone parlor (C), and one 400 head, naturally-ventilated barn with stirring fans and a parallel parlor (D). Electricity was monitored from July 2018 to January 2019. Multiple electric loads were monitored on the farm side of the electric utility meter at the circuits to reveal areas of highest usage. Electrical use was calculated on an electrical load basis. Despite barn design and capacity differences, ventilation was the largest user of electricity across farms A, B, and C. Ventilation use ranged from 17% to 41% of total electricity used across all farms. Other large users of total electricity varied across the farms. Electricity for lighting ranged from 7 to 20% of total electricity usage. Manure handling ranged from 0 to 24% of total electricity. Milk cooling (compressors and chillers) ranged from 5 to 21% of total electricity. Approximately 14% of the electricity in the automatic dairy was used to operate the automatic milking system. Improving the efficiency of electrical components could provide opportunities to improve the carbon footprint of dairy production systems.

Milestones: Farmers have started to adopt precision technologies for grazing dairy cattle and in calf raising and for fertility and health monitoring of calves and cows. This has resulted in improved labor efficiency on farm, as well as improved fertility for dairy cows.

We have conducted many outreach events at the University of Minnesota that have provided dairy producers, consultants, and dairy industry representatives with valuable information that will be able to enhance the profitability of the organic and grazing dairy industry in the United States.

Impacts: 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-2042 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. The 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.

Publications:

Peer-reviewed:

Cousillas-Boam, G., W. Weber, A. Benjamin, S. Kahl, B. Heins, T. Elsasser, D. Kerr, and B. Crooker. 2020. Effect of Holstein genotype on innate immune and metabolic responses of heifers to lipopolysaccharide (LPS) administration. Domestic animal endocrinology 70:106374. https://doi.org/10.1016/j.domaniend.2019.07.002

Heins, B.J., L. Sjostrom, M.I. Endres, M.R. Carillo, R. King, R. Moon, and U.S. Sorge. 2019. Effects of winter housing systems on production, economics, body weight, body condition score, and bedding cultures for organic dairy cows. Journal of dairy science 102:706–714. https://doi.org/10.3168/jds.2018-14582

Minegishi, K., B. Heins, and G. Pereira. 2019. Peri-estrus activity and rumination time and its application to estrus prediction: Evidence from dairy herds under organic grazing and low-input conventional production. Livestock Science 221:144–154. https://doi.org/10.1016/j.livsci.2019.02.003

Pereira, G.M., and B.J. Heins. 2019. Activity and rumination of Holstein and crossbred cows in an organic grazing and low-input conventional dairy herd. Translational Animal Science 3:txz106. https://doi.org/10.1093/tas/txz106

Phillips, H.N., B.J. Heins, K. Delate, and R. Turnbull. 2019. Yield, nutritional quality, and fatty acid content of organic winter rye (Secale cereale) and winter wheat (Triticum aestivum) forages under cattle (Bos taurus) grazing conditions. BioRxiv 688952. https://doi.org/10.1101/688952

Rauba, J., B. Heins, H. Chester-Jones, H. Diaz, D. Ziegler, J. Linn, and N. Broadwater. 2019. Relationships between protein and energy consumed from milk replacer and starter and calf growth and first-lactation production of Holstein dairy cows. Journal of dairy science 102:301–310. https://doi.org/10.3168/jds.2018-15074.

Shonka-Martin, B., A. Hazel, B. Heins, and L.B. Hansen. 2019a. Three-breed rotational crossbreds of Montbéliarde, Viking Red, and Holstein compared with Holstein cows for dry matter intake, body traits, and production. Journal of dairy science 102:871–882. https://doi.org/10.3168/jds.2018-15318

Shonka-Martin, B., B.J. Heins, and L.B. Hansen. 2019b. Three-breed rotational crossbreds of Montbéliarde, Viking Red, and Holstein compared with Holstein cows for feed efficiency, income over feed cost, and residual feed intake. Journal of dairy science 102:3661–3673. https://doi.org/10.3168/jds.2018-15682

Sjostrom, L., B. Heins, M. Endres, R. Moon, and U. Sorge. 2019. Effects of winter housing system on hygiene, udder health, frostbite, and rumination of dairy cows. Journal of dairy science. https://doi.org/10.3168/jds.2018-15759

Abstracts:

Pereira, G.M., B. J. Heins, and K. T. Sharpe. 2019. Validation of the RumiWatchSystem to monitor feeding and locomotive behaviors in a grazing dairy herd. J. Dairy Sci. Vol. 102, Suppl. 2 Abstr 219

Pereira, G.M., B. J. Heins, B. O'Brien, A. McDonagh, L. Lidauer, and F. Kickinger. 2019. Validation of an ear tag for grazing behavior in Minnesota and Ireland. J. Dairy Sci. Vol. 102, Suppl. 2 Abstr 220

Perttu, R, B. Heins, H. Phillips, M. Endres. 2019. Are fly avoidance behaviors of dairy cows housed on pasture influenced by the use of mesh fly leggings? J. Dairy Sci. Vol. 102, Suppl. 2 Abstr W2.

Sharpe, K. and B. Heins. 2019. Growth, health, and economics of dairy calves fed organic milk replacer versus whole milk in an automated feeding system. J. Dairy Sci. Vol. 102, Suppl. 2 Abstr 224

Sharpe, K., B. Heins, E. Buchanan, M. Cotter, and M. Reese. 2019. Electrical energy consumption in four commercial Midwest dairy barns. J. Dairy Sci. Vol. 102, Suppl. 2 Abstr 485

University of Missouri (Skevas)

Project Director

Theodoros Skevas

Recipient Organization

University of Missouri

Performing Department

Division of Applied Social Sciences

Non-Technical Summary : (limit to 2500 characters with spaces)

This project examines the role of peer influence in the analysis of farm performance as measured by dynamic productivity growth and its components (namely dynamic technical inefficiency change, dynamic technical change, and dynamic scale inefficiency change). The empirical application focuses on panel data of Wisconsin dairy farms observed over the 2009 -2017 period. Results show that peer effects play an important role in explaining farm performance. The fact that interdependence between neighboring farms affects their performance, implies that policies aiming at improving farm performance should not assume independent farmer behavior but account for spatial interactions among neighboring farms. For instance, extension programs aiming at promoting productivity enhancing management practices and technologies may target neighborhood networks (rather than individuals) and take advantage of existing interactions between neighbors to more efficiently reach their goals.

Keywords: (limit to 4)

Productivity growth, peer effects, spatial spillovers, dairy farms

Goals / Objectives (limit to 500 characters with spaces)

Examine whether neighboring farmers' characteristics influence a farmer's dynamic productivity growth and its components.

Project Methods (limit to 2500 characters with spaces)

The methodology consists of two steps. First, data envelopment analysis was used to measure farm dynamic productivity growth and its components. The dynamics accounted for by this analysis are related to the gradual adjustment of quasi-fixed production factors (e.g. farm machinery and equipment) in the presence of adjustment costs. Second, spatial bootstrap panel data analysis was used to measure the effect of own and neighboring farmers' characteristics on farm productivity growth and its decompositions.

Outputs (limit to 1000 characters with spaces)

We found that neighboring farmers' financial and production decisions and characteristics influence farm dynamic productivity growth and its components. Higher liquidity and subsidies for neighbors decrease a farm's dynamic productivity growth and its components, while higher debt and savings have the opposite effect. Regarding farmers' production characteristics, farmers with neighbors that own more of the land they farm, have cows with elevated somatic cell count (SCC), and use pasture land for cattle grazing experience declines in dynamic productivity growth and its components. One channel through which neighboring farmers' characteristics may affect farm performance is through information sharing and influence between neighboring farmers. For instance, if farms with high SCC lack the knowledge to control mastitis and give wrong information about mastitis prevention and control to their neighbors, then the neighborhood-level productivity may decrease.

Impacts (Limit to 250 characters with spaces)

Policy makers can take advantage of peer influence among neighboring farmers to propagate more efficiently productivity-enhancing technologies and management practices.

Publications

Peer Reviewed

Abstracts

Extension Publications and others:

Skevas, T. and Cabrera, V.E. Spatial dependence and dynamic productivity growth in Wisconsin dairy farming. Selected Paper prepared for presentation at the 2019 Agricultural and Applied Economics Association Annual Meeting, Atlanta, GA, July 21-23. Available at: https://ageconsearch.umn.edu/record/291178?ln=en

University of New Hampshire (Erickson)

Project Director: Peter Erickson

Recipient Organization: University of New Hampshire

Performing Department: Agriculture, Nutrition, and Food Systems

Non-Technical Summary : (limit to 2500 characters with spaces)
Three experiments were conducted and completed in 2018-2019 under objective 1.

Experiment 1 involved the supplementation of newborn calves with lacteal based colostrum replacer (CR) providing 180g IgG with or without the addition of a non-steroidal anti-inflammatory drug (meloxicam; MEL) at 1 mg/kg BW. The treatments were control meloxicam, meloxicam added to colostrum replacer or meloxicam dosed before colostrum replacer. Calves were then fed an all milk milk-replacer (4L), free choice calf starter and water for 6 weeks. Results indicated that apparent efficiency of absorption at 12h of age was less for MEL calves and that starter intake was tended to be greater for MEL treated calves. No other characteristics measured were different.

Experiment 2, post-weaned heifers were fed a totally mixed ration for 12 weeks and fed either control, 0.75 g/kg sodium butyrate (B), 1 mg/kg monensin (M), or the combination of B and M (BM). Weekly skeletal measures, BW, coccidial counts, blood ketones, and glucose were determined. Daily feed intake was used to determine feed efficiency. During week 3 and week 9, heifers were evaluated for nutrient digestibilities using acid-insoluble ash. Heifers fed B, M or BM consumed more dry matter than control calves. While heifers fed B tended to consume more DM than heifers fed M. There was no effect of treatment on average daily gain. However, the heifers fed M were more efficient in converting feed to gain than calves fed B or BM. Overall, there was no difference in feed efficiency among treatments. Final body weight tended to greater for calves fed B, M or BM compared to control. Overall BW gain was similar among treatments, while heifers fed an additive tended to have greater final body weight. Heart girth tended to be greater in heifers fed BM than either B or M fed separately. Blood ketones were greater for heifers fed any B treatment than control. Blood glucose for heifers fed either B or M tended to be greater than heifers fed BM. NDF digestibility tended during week 9 and less for heifers fed B, M or BM compared to control. Coccidia counts were less for B, M or BM compared to control heifers.

Experiment 3, heifers were in a limit-fed trial to evaluate wet brewer's grains (WBG). WBG replaced corn and soybean meal either completely (20% DM) or 10% (DM). Results indicated that WBG can replace corn and soybean meal. Total tract nutrient digestibility was improved with 0% or 20% WBG compared to 10% WBG.

Keywords: (limit to 4)
Non-steroidal anti-inflammatory drug
Sodium butyrate

Monensin
Wet brewer's grains

Goals / Objectives (limit to 500 characters with spaces)
The goals of these experiments were to improve calf health (exp.1), evaluate a new feed additive (exp.2) and determine if wet brewer's grains can replace corn meal and soybean meal in yearling heifers.

Project Methods (limit to 2500 characters with spaces)
Growth experiments that included a digestibility component (Experiments 2 and 3) or evaluation of immune status (exp.1) were conducted. Cattle were weighed weekly (exp. 1 and 2) or bi-weekly experiment 3. Blood parameters were measured in experiment 1 and 2 as indicators of gut development to determine if treatments had any impact on these characteristics. Coccidia oocysts were counted weekly in experiment 2.

All studies utilized randomized complete block designs with initial measurements serving as covariates. Orthogonal comparisons were conducted for all experiments. Experiment 1 evaluated control versus meloxicam or the method of providing the drug. Experiment 2 evaluated the effect of feeding an additive versus control, one additive versus the other or the individual additives versus the combination. Experiment 3 evaluated the linear and quadratic effects of adding wet brewer's grains.

Impacts

Experiment 1- Meloxicam was of no benefit to newborn calves or on growth rate preweaning.

Experiment 2- Any additive improved performance and sodium butyrate was as effective as monensin in almost all parameters measured except feed efficiency including a reduction in coccidian counts.

Sodium butyrate is an alternative to monensin in heifer diets.

Experiment 3- Wet brewer's grains can replace corn and soybean meal in yearling heifer diets, thereby reducing costs for producers.

Publications

Peer-Reviewed:

Hatungimana, E., and P.S. Erickson. 2019. Effect of storage of wet brewer's grains treated with salt or a commercially available preservative on aerobic stability, on in vitro and in situ dry matter digestibility and intestinal protein digestibility. Appl. Anim. Sci. (accepted)
Conroy, A.B., C.E. Overson, and P.S. Erickson. 2018. Alumni perspectives of using a flipped classroom and experiential learning at a university dairy farm. North ACTA J. 63:299-306.

Chapman, C.E., S. B. Ort, K. M. Aragona, R. G. Cabral, and P. S. Erickson. 2019. Effect of cinnamaldehyde on feed intake, rumen fermentation, nutrient digestibility, and milk components in lactating dairy cows. J. Anim. Sci. 97:1819-1827.

Rice, E.M., K.M. Aragona**,** S. C. Moreland, and P.S. Erickson. 2019. Supplementation of sodium butyrate to post-weaned heifer diets: Effects on growth performance, nutrient digestibility, and health. J. Dairy Sci.102:3121-3130.

Abstracts:

Anderson, J.L., P. S. Erickson, K. F. Kalscheur, and G. J. Lascano. 2019. Strategies to improve efficiency and profitability of heifer raising. J. Dairy Sci. 102 (Suppl.1): 304.

Heinrichs, A.J., P. S. Erickson, H. Chester-Jones, and C. M. Jones. 2019. Colostrum management and calf nutrition for profitable and sustainable dairy farms. J. Dairy Sci. 102 (Suppl. 1): 303.

Extension Publications and others:

Erickson, P.S. 2018. Finn Strudsholm in Kvæg Special. Oktober. 2018. Kvier hae en kritisk periode, hvor yverudviklingen hæmmes as for stærk fodring (Danish Dairy Magazine).

Intermountain Farmer's Cooperative Annual Meeting, February 2019. Does raising a successful calf begin with Mom?

Intermountain Farmer's Cooperative Annual Meeting, February 2019. Limit feeding dairy heifers

Book Chapter:

Erickson, Peter and Kenneth Kalscheur. 2019. Nutrition and Feeding of Dairy Cattle in Animal Agriculture: Sustainability, Challenges and Innovations. Elsevier, Amsterdam.

Penn State University (Heinrichs)

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, C. A. Jones, L. A. Mitchell, G. A. Chishti, A. Lopez.

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:

Comparison of IgG absorption in calves fed a commercial colostrum replacer or supplement maternal colostrum

This study compared a colostrum supplement fed at 2 level of IgG intake with a low-quality colostrum supplemented with a colostrum replacer and a high-quality maternal colostrum. A total of 80 Holstein calves were randomly assigned to one of the 4 colostrum treatments. Blood samples were taken at 0 and 24 h after birth to determine immunoglobulin G levels and absorption. In addition, calves were followed through 7 weeks of age for health and growth observations. Calves fed maternal colostrum had higher immunoglobulin G values at 24 h, but calves fed the replacer at both levels generally had acceptable values. Efficiency of IgG absorption was greater in calves fed replacer or supplemented maternal colostrum than maternal colostrum by itself. No differences were found in growth and health parameters between treatments. These results suggest that this colostrum replacer can be an acceptable alternative to maternal colostrum feeding.

Impact of various forages and live yeast culture on weaned dairy calf intake, growth, nutrient digestibility, and rumen fermentation

The objective was to determine effects of various forages and live yeast culture on intake, growth, nutrient digestibility, and rumen fermentation of weaned dairy calves. Holstein calves (n = 45) were randomly assigned to 2 x 3 factorial treatments: live yeast culture (Y; Yea-Sacc, Alltech, Inc.) or no yeast (NY) and alfalfa haylage (AH), corn silage (CS), or grass hay (GH). After 9 wk, feed was offered as a total mixed ration (TMR). Concentrate intake was capped at 2.25 kg of dry matter (DM)/d, while forage was offered ad libitum. The TMR contained equal

forage neutral detergent fiber (NDF; 8 ± 0.5%) on a DM basis. Calves were fed TMR to limit concentrate intake, and additional forage was offered ad libitum after 8 h if the entire TMR allotment was consumed. Dry matter and metabolizable energy intake was least for calves consuming GH vs. other forages ($P < 0.05$). Forage intake as % DMI increased as calves aged (AH = 20 to 44.4%, CS = 24.5 to 37.6%, GH = 11.3 to 32.3% at 10 and 16 wk of age respectively). Calves on CS had the greatest average daily gain and empty BW gain, while calves on GH had the least. Calves on GH tended to have the lowest final BW ($P = 0.09$). There were no differences in structural growth. Digestibility of DM decreased with age (wk 11, 73.46 vs. wk 15, 71.22%; $P < 0.05$). Fiber digestibility was least for calves on CS ($P < 0.05$). Starch digestibility was least for calves on AH (CS = 93.94, GH = 93.14, AH = 88.29%; $P < 0.05$). Mean and minimum rumen pH increased with age ($P = 0.07$; $P < 0.05$ respectively). Forage offered changed VFA profile and there was an interaction between yeast and forage on VFA profile. These results indicate that recently weaned calves have minimal benefit from yeast supplementation and perform well on either AH, CS, or GH. While feeding GH reduced weight gain, these calves were still on track to meet growth goals for breeding and freshening. Furthermore, the ability to consume large portions of their ration as forage allows for more economical diets to be fed. Studies are continuing in this area.

Relationships between physical form of oats in starter, rumen pH and volatile fatty acids on hepatic expression of genes involved in metabolism and inflammation in dairy calves. Dietary effects on hepatic metabolism have not been studied in pre-weaned calves. This study explored effects of physical forms of oat grain in calf starter on gene expression of key hepatic enzymes in pre-weaned dairy calves. Expression of hepatic enzymes was not affected by the physical form of oats in the diet, rather these changes were influenced by rumen pH. These results show that along with rumen development, important adaptive changes in the calf's liver also are taking place in early life.

Objective 3-
Advancing Sustainable Cropping Systems for Dairy Farms in the Northeastern US

Double cropping may improve profitability through increased DM yields per ha and increased manure nutrient application per ha, while reducing nitrogen (**N**) and phosphorus (**P**) pollution. The objective of this study was to evaluate the impact of double cropping winter annuals and corn on nutrient cycling, total feed cost, and net return to management as feed prices and the percentage of corn land double cropped changed. At total of eight farm simulations were done using the Integrated Farm System Model (**IFSM**) and crop, dairy, and financial data from three dairy farms that practiced double cropping. Farms ranged from 336 to 511 ha with 233 to 663 cows. Farms were simulated over a 20-year time period using weather data from DuBois, Pennsylvania. Eight scenarios measuring intensity of double cropping and change in feed price for each farm were simulated. These included: current operation, 0, 50, and 100% of corn land double cropped, 30% relative feed price increase with and without double cropping, and 30% feed price decrease with and without double cropping at current operation level. Double cropping 100% compared to 0% of corn land improved total DM yield by 19% while reducing annual N leached and P runoff losses by an average of 4.5% and 9.2%, respectively, across farms. Double cropping provided a 1.3 and 1.8% increase in net return over feed costs and net return to

management, respectively, across farms. When feed prices increased 30%, use of double cropping increased net return over feed cost and net return to management by 1.6 and 2.2%, respectively, across farms. Simulation with the IFSM showed that use of double cropping improved profitability on farms during times of average to high feed prices. Loss of N and P decreased with double cropping, but use of N fertilizer with winter annuals reduced this benefit.

D. USEFULNESS OF FINDINGS:

Newly weaned calves offer a much-needed area of research. Often calves are well grown at weaning and recent research has demonstrated various systems to accomplish well-grown calves at 6 to 8 weeks of age. However, after this period, many farms struggle with maintaining optimum growth rates of calves during the transition from monogastric calves to ruminant heifers. Little research is in the literature related to calves of this age group. Therefore there is great need for this type of research to be done to provide nutrient recommendations as well as feeding system that generally allow these young calves to continue their track to growing enabling them to reach 55%of mature body weight by 11 to 12 months of age.

Use of the IFSM allowed for evaluating double cropping systems over a wide variety of weather conditions. Scenarios with higher feed prices resulted in more positive economic benefits from double cropping. Loss of N and P in dairy farm systems using double cropping decreased, but the impact of fertilization and less exporting of nutrients from crop sales negated this environmental benefit. Therefore, there is a need to evaluate the winter annuals that are double cropped both in terms of crop cost and in terms of nutrient balance to the whole farm system.

E. PUBLICATIONS:

Peer-reviewed/ research and extension.

D. Cavallini, L.M.E. Mammi, M. Fustini, A. Palmonari, A.J. Heinrichs, A. Formigoni. 2018. Effects of ad libitum or restricted access to total mixed ration with supplemental long hay on production, intake, and rumination. Journal of Dairy Science, Vol. 101, Issue 12, p10922–10928.

K. Kljak, B.S. Heinrichs, A.J. Heinrichs. 2019. Fecal particle dry matter and fiber distribution of heifers fed ad libitum and restricted with low and high forage quality. Journal of Dairy Science, Vol. 102, Issue 5, p4694–4703.

E.J. Ranck, L. A. Holden, and K.J. Soder. 2019. Short Communication: Evaluating feed cost, income over feed cost, and the cost of production for milk and crops on 4 case study farms that double cropped winter annual silage and corn silage for 2 years in northern and western Pennsylvania. Applied Animal Science, Vol. 35, Iss. 1. p 74-83.

D.J. Saldana, S.L. Gelsinger, C.M. Jones, A.J. Heinrichs. 2019.Effect of different heating times of high-, medium-, and low-quality colostrum on immunoglobulin G absorption in dairy calves. Journal of Dairy Science, Vol. 102, Issue 3, p2068–2074.

D.J. Saldana, C.M. Jones, A.M. Gehman, A.J. Heinrichs. 2019. Effects of once- versus twice-a-day feeding of pasteurized milk supplemented with yeast-derived feed additives on

growth and health in female dairy calves. Journal of Dairy Science, Vol. 102, Issue 4, p3654–3660.

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

Lopez, A. J., C. M. Jones, A. J. Geiger, and A. J. Heinrichs. 2019. Comparison of IG absorption in calves fed a commercial colostrum replacer or supplemented maternal colostrum. J. Dairy Sci (Suppl. 1) 102:14.
Turielo, P., C. Vissio, A. Larriestra, and A. J. Heinrichs. 2019. Assocoation between age at first calving and productive performance in Argentinan dairy herds. J. Dairy Sci (Suppl. 1) 102:58.
Mitchell, L. K., and A. J. Heinrichs. 2019. Impact of increasing grass hay inclusion level on weaned calf growth and metabolism. J. Dairy Sci (Suppl. 1) 102:263.
Heinrichs, A. J., P. S. Erickson, H. Chester-Jones and C. M. Jones. 2019. Colostrum management and calf nutrition for profitable and sustainable dairy farms. J. Dairy Sci (Suppl. 1) 102:303.
Heinrichs, A. J., A. DiFranca, F. Masucci, F. Serrapica, and C. M. Jones. 2019. A survey of diet characteristics related to feed particle size on buffalo farms in southern Italy. J. Dairy Sci (Suppl. 1) 102:354-355.
Heinrichs, J., C. Jones and R. Goodling. 2019. How many heifers do we need? Hoards Dairyman. 164:383.
Heinrichs, J., C. Jones and C. Yost. 2019. A weight tape worth $1000. Hoards Dairyman. 164:428.
Ranck, E. J, L. A. Holden, K. J. Soder, J. A. Dillon, and C. A. Rotz. 2019. Use of the Integrated Farm System Model to determine economic and environmental impacts of double cropping winter annuals with corn. J. Dairy Sci. (Suppl. 1). 102: 57.

F. IMPACT STATEMENT

Dairy calves can be fed whey-based colostrum substitutes and supplements and effectively gain high levels of IgG protection.
Dairy heifers can be fed in a manner that is more environmentally and cost efficient with no adverse effects. They can be fed total mixed rations of higher forage amounts than has been often done in the past.
Use of the IFSM model allowed for long term evaluation of double cropped winter annuals with corn under a variety of practical farm scenarios. Double cropping provided the most economic benefit during years of high feed prices. The cycling of N and P with double crop systems was greatly impacted in the model by fertilization rates and removal of crops off the farm through sale of excess feed. Farms using double cropping have the potential to realize both economic and environmental benefit under a variety of conditions.

Purdue University (Boerman)

Personnel: Jacquelyn Boerman (project leader), Rebecca Klopp (PhD student), Tabitha Steckler (MS student), and Conor McCabe (MS student)

Collaborators: Theresa Casey and Aridany Suarez-Trujillo, Animal Sciences Department, Purdue University; Amy Reibman, Electrical and Computer Engineering, Purdue University

Performing Department: Purdue University, Animal Sciences Department

Non-Technical Summary : (limit to 2500 characters with spaces)

Under objective 1:

a.) The raising of calves and heifers represents a large cost for dairy producers. A considerable amount of data is currently collected from dairy farms on calves and heifers. Combining both phenotypic and genotypic information about early life of calves may allow for better decision making on farms related to how to allocate resources on farms. We are looking at relationships between early life data (i.e. milk consumption, health events, genetic information, and body weight) and future growth or milk production to determine if we can rank calves based on their likelihood of being profitable.

b.) As an approach to reduce antibiotic use, we are investigating the efficacy of direct fed microbials fed to calves to improve growth and health outcomes.

Under objective 2:

a.) During the transition from late gestation to early lactation, cows undergo considerable metabolic adaptation to support lactation. Both adipose and adipose tissue are mobilized in order to meet the increasing energy and amino acid requirements not met through intake. We are conducting research trials to understand the timing and extent of tissue mobilization. Understanding how much and when tissue is mobilized will allow for more accurate estimates of energy and protein requirements throughout the transition period.

Under objective 3:

a.) Lameness is an animal welfare concern as well as an economic opportunity on most dairy farms. One issue with reducing lameness is accurate and early detection of lame cows. We are developing a video based system that will identify a cow and several anatomical points on that cow. An assessment of lameness will be made based on the movement of those anatomical points relative to one another. We will use video analytics to develop an algorithm to assign a lameness score to each cow in order to constantly monitor lameness on dairy farms. This will remove subjectivity and increase the number of times a cow is observed for lameness, with the ultimate goal of reducing lameness on dairy farms.

Keywords: tissue mobilization, calf growth, video analytics, calf health

Goals / Objectives (limit to 500 characters with spaces)

Objective 1:

a.) Utilize data generated from dairy farms within the first 60 days of life of a calf to predict the likelihood of a calf developing into a productive cow.

b.) Determine if direct fed microbials can be fed to dairy calves to reduce antibiotic use and increase feed efficiency.

Objective 2:

a.) Determine the extent and timing of tissue mobilization in dairy cattle.

Objective 3:

a.) Evaluate if video analytics can be used to detect changes in appearance and behavior of dairy cattle.

Project Methods (limit to 2500 characters with spaces)

Objective 1:

a.) Partnering with a commercial dairy farm in Indian, we obtained birth weights, serum total protein values, health records, total milk consumption, weights throughout life, genomic information, and milk production for 10,000 dairy calves fed through an automated calf feeding system. The data was collected from the auto feeder software, DairyComp305, CLARIFIDE program, and AfiMilk system. Data was combined from these sources to determine the effects of early life milk consumption on growth, reproductive success, and future milk production.

b.) Holstein bull calves were blocked by birthweight and serum total protein and assigned to one of two treatments, Control and Direct Fed Microbial. Intake of milk replacer (1 – 56 d) and grain (1 – 112 d) was measured. Health events and biweekly growth data was recorded and fecal samples were collected for fecal microbiome analysis. Towards the end of the pre-weaning period, calves were given an immune challenge to determine if the DFM has an impact on immune status of the calves.

Objective 2:

a.) Cows were blocked by previous milk production and previous disease incidences and assigned to one of two treatments. Cows were monitored from 7 weeks prior to calving to 60 DIM. Feed intake was monitored throughout the study and milk yield was recorded from 1-60 DIM. Body weight, body condition score, blood samples and ultrasound scans of the longissmus dorsi muscle were taken at 8 time points throughout the study.

Objective 3:

a.) We utilize a four camera system to observe the movement of cows walking from the milking parlor at the Purdue Research Farm. The first step is to isolate cows in video footage then automatically label multiple locations of the dairy cow. Human labelers evaluate the locomotion of a sub-set of cows to develop the algorithm that will automatically predict locomotion on a separate population of cows.

Outputs (limit to 1000 characters with spaces)

In addition to publications the outputs of this research include the training of 3 graduate students, 10 undergraduate students and 2 interns in dairy nutrition and management.

Impacts (Limit to 250 characters with spaces)
Objective 1: The commercial farm has adopted lung ultrasonography of calves based on the value they observed with our measurements.

Objective 2: Accurate estimates of tissue mobilization will increase the accuracy of nutrient requirements through early lactation.

Publications

Peer Reviewed:

1. McCabe, C. J. and J. P. Boerman. 2019 Quantifying protein mobilizating in the transiton dairy cow. Applied Anim. Sci. *In Review.*

2. Suarez-Trujillo, A., G. Wernert, H. Sun, T. S. Steckler, S. Cummings, K. Huff, J. Franco, R. Klopp, J. Townsend, M. Grott, J. Johnson, K. Plaut, J. P. Boerman, and T. Casey. 2019. Exposure to chronic light-dark phase shifts during the prepartum non-lactating period attenuates circadian rhythms, decreases blood glucose and increases milk yield in the subsequent lactation. J. Dairy Sci. *In Review.*
3. Boerman, J. P. 2019. Quantifying tissue mobilization in transition dairy cows. Proceedings of the Tri-State Dairy Nutrition Conference, Fort Wayne, IN, USA, 22-24 April, 2019 Editor: Eastridge, M. L.:67-74.
4. Boerman, J. P. 2019. Review of meta-analyses for fatty acid digestibility. 36th American Dairy Science Discover Conference: Lipids in Dairy Nutrition: From Feed to Milk Fat. Itasca, IL. May 29 – May 31, 2019.

Abstracts:

1. Klopp, R., T. S. Steckler, A. Suarez-Trujillo, M. Grott, J. R. Townsend, K. Plaut, T. M. Casey, and J. P. Boerman. 2019. Effects of circadian rhythm disruption during the dry period on tissue mobilization in multiparous dairy cattle. J. Dairy Sci. Vol. 102. (Suppl. 1):269.
2. Steckler, T. S., M. A. Erasmus, and J. P. Boerman. 2019. Milk consumption differs by breed and lung consolidation score in automated feeding systems. J. Dairy Sci. Vol. 102. (Suppl. 1):415.
3. Steckler, T. S. and J. P. Boerman. 2019. Effects of breed and health incidences on total milk consumption and predicted body weight of Holstein and Angus × Holstein F1 calves during the pre-weaning period. J. Dairy Sci. Vol. 102. (Suppl. 1):335.

Extension Publications and others:

1. Steckler, T. S. and J. P. Boerman. 2019. Lung ultrasonagraphy: a visual way to detect lung damage. Extension Publication. *In Review.*

University of Wisconsin (Akins)

Project Director
Matt Akins

Personnel
Chelsey Hribar (MS student), Lingyan Li (Visiting scholar)

Collaborators: Nancy Esser, Jason Cavadini, Dan Schaefer, Mark Cook, University of Wisconsin; Wayne Coblentz, Geoff Brink, Michael Casler; USDA Dairy Forage Research Center

Recipient Organization
University of Wisconsin-Madison

Performing Department
Dairy Science

Non-Technical Summary:

Research completed in the past year evaluated the growth of dairy heifers grazing different grass species and the use of an egg antibody supplement to control an intestinal parasite in heifers.

Heifers grazing either orchardgrass or meadow fescue had similar weight gains when using a rotational grazing system. However, meadow fescue had improved forage production and quality over the 3-year study compared to orchardgrass which may allow for greater persistence over time and animal production per acre. Maintaining the forage in a vegetative state by use of clipping of reproductive plants was very important to maintain productive forages, but difficult when weather conditions did not allow for clipping.

A study with feeding an egg-based antibody to interleukin-10 to recently transported dairy heifers will be completed in November 2019. The antibody is thought to help the animal's immune system respond to an intestinal protozoa (Eimeria species or coccidia) and improve weight gain and feed efficiency compared to animals not treated for the disease. Previous work did not find a difference in growth or health of these heifers, but the timing of feeding did not match with the occurrence of the infection. The current study changed the supplementation timing to match with the infection and improve response to the antibody. Results will be presented in the next year's report.

Keywords:
dairy heifer, forage, health

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

Project Methods

Dairy heifer growth while grazing meadow fescue or orchardgrass (part of thesis by Chelsey Hribar)

C. Hribar, M. Akins, W. Coblentz, M. Casler, J. Bleier, G. Brink

Our objective was to evaluate pasture productivity and dairy heifer growth when grazing either meadow fescue (MF) or orchardgrass (OG). Six pastures (1 ha each) were used with 3 blocks (2 pastures/block) and grass treatment randomized within each block. Pre-pubescent heifers (n=24) were blocked by weight and randomly assigned to graze MF or OG in each block with 4 heifers per pasture. Three years of study were completed with different heifers used each year. No supplemental concentrates were provided. Grazing commenced in late May and completed in mid to late October depending on available forage and freezing temperatures. Pastures were managed using rotational grazing with heifers moved two times each week (every 3-4 days). Forage height measures were taken at each move with a rising plate meter. Calibration of height measures to estimate forage availability was done by clipping 3 locations in each pasture with forage quality analyzed using near infrared spectrometry. MF had higher pre-grazing forage availability (1159, 1512, and 1870 kg/ha in 2016, 2017, and 2018, respectively) than OG (1130, 1282, 1672 kg/ha for 2016, 2017, and 2018, respectively). MF also had higher NDFD (69.4, 61.3, and 70.0% for 2016, 2017, and 2018 respectively) than OG (64.7, 58.8, and 68.9% for 2016, 2017, and 2018 respectively). Average daily gains were similar for heifers grazing MF (0.78 kg/d) and OG (0.74 kg/d). Hip height gains and body condition change were also similar between MF and OG. Based on these results, both grass species are suitable forage sources for grazing young heifers and able to meet nutrient needs under a managed grazing system. Proper management (fertilization, residue height, harvesting/clipping) are needed to maintain high forage quality and growth.

Impacts:
Costs to raise dairy heifers is significant at $1800-2200 from birth to calving based on Wisconsin survey data. Use of grazing can substantially reduce rearing costs due to reduced labor, machinery and facility use, fuel, and use of harvested forages or purchased feeds while allowing for heifer growth at industry standards as demonstrated in this project and in several other studies. In addition, grazing allows for establishment of more area in perennial forage systems that can reduce environmental impact compared to annual cropping systems.

Publications 2018-2019

Peer Reviewed

Li, L., N. M. Esser, R. K. Ogden, W. K. Coblentz, and M. S. Akins. *Accepted* 2019. Effects of feeding two different types of sorghum-sudangrass silage based diets on nutrient intake and digestibility and growth of Holstein dairy heifers. J. Dairy Sci

Williams, K. T., K. A Weigel, W. K. Coblentz, N. M. Esser, H. Schlesser, P. C. Hoffman, M. S. Akins. 2019. Effect of diet energy density and genomic residual feed intake on pre-bred dairy heifer feed efficiency, growth, and manure excretion. J. Dairy Sci. 102:4041-4050.

Abstracts

Grisham, A., D. Schaefer, C. Nolden, M. Akins. 2019. Growth and health of recently transported dairy heifers fed a novel antibody to interleukin-10. J. Dairy Sci. 102: E-supplement 1.

Hribar, C., J. Cavadini, M. Akins. 2019. Comparison of growth and relationship with genomic body size for dairy heifers managed in confinement or on pasture. J. Dairy Sci. 102: E-supplement 1.

Hribar, C., G. Brink, J. Bleier, M. Casler, W. Coblentz, R. Ogden, J. Cavadini, M. Akins. 2019. Dairy heifer growth while grazing meadow fescue or orchardgrass. J. Dairy Sci. 102: E-supplement 1.

Li, L., N. Esser, R. Ogden, W. Coblentz, M. Akins. 2019. Effects of feeding two different types of sorghum-sudangrass silage based diets on nutrient intake and digestibility and growth of Holstein dairy heifers. J. Dairy Sci. 102: E-supplement 1.

Extension and popular-press articles

Hribar, C., M. Akins, G. Brink, W. Coblentz, J. Bleier, R. Ogden. May 2019. Dairy heifer growth while grazing meadow fescue or orchardgrass. Midwest Forage Focus. Published by Midwest Forage Association

Hribar, C., M. Akins, G. Brink, W. Coblentz, J. Bleier, R. Ogden. 2019. Heifer growth with rotational grazing systems. Dairy Line. Published by Professional Dairy Producers of Wisconsin.

University of Wisconsin (Cabrera)

NC 2042: 2018 - 2019 Station Report
Victor E. Cabrera

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

COOPERATING AGENCY and personnel: *UNIVERSITY OF WISCONSIN, Dairy Science,*

Real-time continuous decision making using big data on dairy farms.
Cabrera, V. E., J. A. Barrientos-Blanco, H. Delgado, and L. Fadul-Pacheco.
We are developing a real-time, data-integrated, data-driven, continuous decision-making engine: The Dairy Brain by applying Precision Farming, Big Data analytics, and the Internet of Things. This is a trans-disciplinary research and extension project that engages multi-disciplinary scientists, dairy farmers, and industry professionals. Dairy farms have embraced large and diverse technological innovations such as sensors and robotic systems, and procured vast amounts of constant data streams, but they have not been able to integrate all this information effectively to improve whole farm decision-making. Consequently, the impact of all this new Smart Dairy Farming is not being fully realized. It is imperative to develop a system that can collect, integrate, manage, and analyze on- and off-farm data in real-time for practical and relevant actions. We are using the state-of-the-art database management system from the University of Wisconsin-Madison Center for High Throughput Computing to develop our Agricultural Data Hub that connects and analyzes cow and herd data on a permanent basis. This involves cleaning and normalizing the data as well as allowing data retrieval on demand. We illustrate our Dairy Brain concept with 3 practical applications: 1) Nutritional grouping that provides a more accurate diet to lactating cows by automatically allocating cows to pens according to their nutritional requirements aggregating and analyzing data streams from management, feed, Dairy Herd Improvement (DHI), and milking parlor records; 2) Early risk of clinical mastitis (CM) that identifies 1st lactation cows under risk of developing CM by analyzing integrated data from genetic, management, and DHI records; and 3) Predicting CM onset that recognizes cows at higher risk of contracting CM by continuously integrating and analyzing data from management and milking parlor. We demonstrate with these applications that it is possible to develop integrated continuous decision support tools that could potentially reduce diet costs by $99/cow per yr and that it is possible to provide a new dimension for monitoring health events by identifying cows at higher risk of CM and by detecting 90% of the CM cases a few milkings before the disease onset. We are securely advancing towards our overarching goal of developing our Dairy Brain. This is an ongoing innovative project that is anticipated to transform how dairy farms operate.

The relationship between the number of consecutive days with heat stress and production performance of Holstein dairy cows raised in a continental climate.
Ouellet, V., V. E. Cabrera, L. Fadul-Pacheco, and É. Charbonneau.

Heat stress is known to put a strain on production performance in dairy cows. This condition is naturally associated with dairy cows experiencing high temperatures and relative humidity over a prolonged period of time. However, research on its consequences in colder areas of the globe is scarce. The objective of the present study was to describe the prevalence of days susceptible to cause heat stress in dairy cows raised in 2 dairy regions characterized by a continental climate. We also aimed at investigating the relationship between the number of consecutive days susceptible to cause heat stress and milk, fat, protein, and lactose yields (kg/d) and milk composition (fat, protein, lactose %). The initial data set used in this study comprised 606,031 test day (TD) records from 34,360 Holstein dairy cows of different lactations. Data were collected from 2010 through 2015 in 2 regions in Quebec, Canada: Southwest Quebec (SWQ), East Quebec (EQ). Weather data (2010-2015) were retrieved from 8 meteorological stations. Daily maximum temperature-humidity index (THI_{max}) were calculated using maximum daily temperature (°C) and minimum relative humidity (%). The number of consecutive days with heat stress was divided in categories: 0 = no days with heat stress; 1-2 = 1 or 2 consecutive d with heat stress; 3-4 = 3 or 4 consecutive d with heat stress; 5-6 = 5 or 6 consecutive d with heat stress; 7-8 = 7 or 8 consecutive d with heat stress. On average, for the years 2010-2015, dairy cows were exposed to 135.8 ± 5.9 and 95.3 ± 10.2 d/yr prone to cause heat stress in SWQ and EQ, respectively. Our results suggested that dairy cows exposed to days susceptible to cause heat stress produced on average less ($P < 0.05$) ECM, fat, protein (kg/d) and had lower milk fat and protein concentrations on test day than cows not exposed to heat stress. A maximum difference of 6% was observed in milk fat yield (kg/d) between cows of third lactation and greater not exposed to heat stress and cows subjected to 7-8 consecutive days with heat stress. Interestingly, the number of consecutive days with heat stress was not associated ($P > 0.05$) with lower milk yield and milk lactose (yield and %) on test day. In summary, results of this study demonstrated that dairy cows raised in a continental climate are exposed to conditions susceptible to cause heat stress. In addition, cows exposed to an increased number of consecutive days with heat stress had lower milk component (fat and protein) yields and composition while milk yield remained unchanged. Further research is necessary to understand better the mechanism behind the effects of heat stress on milk components of dairy cows exposed to sporadic heat stress episodes of low to medium severity.

A new modeling environment for integrated dairy system management.

Kebreab, E., K. F. Reed, V. E. Cabrera, P. E. Vadas, G. Thoma, and J. M. Tricarico.

- A system approach is needed to enhance understanding of the nature of interactions among the different elements of the food and agricultural system that can be leveraged to increase overall farms' system efficiency, resilience, and sustainability.

- The application and integration of data sciences, soft- ware tools, and systems models will enable advanced analytics for managing the food and agricultural system.

- The goal of whole-farm system modeling is to help develop sustainable dairy production systems, including the wider societal benefit of more efficient production systems while reducing negative environmental impacts.

An income over feed cost nutritional grouping strategy.

Wu, Y., D. Liang, R. D. Shaver, and V. E. Cabrera.

This study introduces a new nutritional grouping method, OptiGroup, which maximizes milk income over feed cost (IOFC) using a mixed-integer nonlin- ear programming optimization algorithm. Analyses compared the OptiGroup with the cluster method, the current state-of-the-art nutritional grouping technique. Analyses were performed using cow-level data from 7 Wisconsin dairy farms. Consistently, the OptiGroup and the cluster were constrained to group cows simulta- neously into 2 (low and high nutrient requirements) and 3 (low, medium, and high nutrient requirements) same- size groups. Each diet satisfied the net energy (NEL) and crude protein (CP) requirements of approximately 83% of the cows in each group by using lead factors based on nutrient density. A control treatment (1-group scenario) was used as a baseline for comparisons. The IOFC, dietary nutrient densities (NEL and CP), and dry matter intake with both methods were computed and compared. The percentage of cows grouped dif- ferently and the percentages of primiparous cows and late-lactation (>200 d in milk) cows in each group were also analyzed. Results were as follows: (1) average ex- tra IOFC of $8/cow per yr (2-group) and $12/cow per yr (3-group) by switching from cluster to OptiGroup method; (2) difference between dietary nutrient densities of the groups were reduced under OptiGroup method compared with cluster (i.e., NEL differences in 2 groups were 0.20 Mcal/kg for the cluster vs. 0.11 Mcal/kg for OptiGroup); (3) dry matter intake de- creased with increasing group numbers within a group- ing method, and decreased from cluster to OptiGroup method with constant group numbers; (4) percentage of primiparous cows was greater in the low group of cluster and in the high group of OptiGroup; and (5) proportion of late-lactation cows tended to be greater in the low group in both grouping strategies. Results indicated that the OptiGroup performed economically better than the cluster because of nutrient savings, even with high feed cost conditions. This study offers a new nutritional grouping paradigm, which could improve herd management on dairy farms. However, animal tri- als are needed to validate this new nutritional grouping method under farm conditions.

A survey of dairy cattle management, crop planning, and forages cost of production in Northern Italy.

Bellingeri, A., V. E. Cabrera, A. Gallo, D. Liang, and F. Masoero.

A survey regarding crop enterprise management, forages cost of production, dairy cattle management including reproductive management, housing, heat abatement, body condition scoring, nutrition, grouping strategies, and income over feed cost performance, was carried out from December 2016 to January 2018 on 50 dairy farms by the Department of Animal Science, Food and Nutrition of Università Cattolica del Sacro Cuore (Piacenza, Italy). A total of 41 herds (82%) completed the survey. Average herd size was 327 ± 162 lactating cows with the average land size of 160 ± 94 ha per farm. Herds were located in the provinces of Cremona (17), Brescia (8), Mantova (7), Piacenza (5), Cuneo (4), Bergamo (3), Lodi (3), Torino (2), and Venezia (1). These farms sold 32.8 ± 2.01 kg of milk/day per cow, had an annual culling rate of 34.0 ± 4.00%, a calving interval of 14.16 ± 0.58 months., and a 21-days pregnancy rate of 17.05 ± 2.58%. Implementing effective management strategies to contrast

the damage caused by *Ostrinia nubilalis*, *Diabrotica spp*. and *Myocastor coypus* were identified as the main crop enterprise challenges. Main forages cultivated were alfalfa and corn silage second seeding with a total cost of production of (€/ha) 1968 ± 362 and 2,581 ± 221, with an average yield of 9.61 ± 1.24 and 17.22 ± 2.46 ton of DM per hectare, respectively. Results of this study can provide useful benchmark or reference for dairy management practices, crops and dairy performances, forages production costs on very well-managed North Italian dairy farms at the present time.

Importance of hoof health in dairy production. Effect of claw disorders on milk production, fertility, and longevity, and their economic impact in Holstein cows.

Krpálková, L., V. E. Cabrera, L. Zavaldilová, and M. Štípková.

The objective of this study was to evaluate the association of hoof health on reproduction and production performance, somatic cell count, and longevity in dairy cattle. The data set consisted of records from 19 145 dairy cows at 11 dairy farms in the Czech Republic during years 1998 to 2016. Observations were grouped according to the number of hoof disease (HD) incidence. Each record included a binary variable indicating if HD was observed. The prevalence (% of all cows) observed with HD and its changes according to parity, milk yield, and calving interval were calculated. Great variability among farms was observed. HD detected in the first month of first lactation was associated with 1.5 kg/day lower milk yield and 58 000 cell/ml higher somatic cell count during first lactation. HD detected in the first month of second lactation was associated with 2.6 kg/day lower milk yield and 45 000 cell/ml higher somatic cell count during second lactation. Results from completed lactations showed that observed HD was associated with significantly lower milk yield: 124 kg less during first lactation and 308 kg less during second lactation. Reproductive performance was the poorest in the group with the highest number of HD observations (frequency) within a single lactation (≥ 4). The higher the number of HD frequency per lactation, the greater was the negative association on production and reproductive performance.

PUBLICATIONS:

Peer-reviewed research and extension Journal papers

1 Ouellet, V., V. E. Cabrera, L. Fadul-Pacheco, and É. Charbonneau. 2019. The relationship between the number of consecutive days with heat stress and production performance of Holstein dairy cows raised in a continental climate. Journal of Dairy Science 102:8537-8545.

2 Kebreab, E., K. F. Reed, V. E. Cabrera, P. E. Vadas, G. Thoma, and J. M. Tricarico. 2019. A new modeling environment for integrated dairy system management. Animal Frontiers 9:25-32.

3 Wu, Y., D. Liang, R. D. Shaver, and V. E. Cabrera. 2019. An income over feed cost nutritional grouping strategy. Journal of Dairy Science 102:4682-4693.

4 Bellingeri, A., V. E. Cabrera, A. Gallo, D. Liang, and F. Masoero. 2019. A survey of dairy cattle management, crop planning, and forages cost of production in Northern Italy. Italian Journal of Animal Science 18-786-798.

5 Krpálková, L., V. E. Cabrera, L. Zavaldilová, and M. Štípková. 2019. Importance of hoof health in dairy production. Effect of claw disorders on milk production, fertility, and longevity, and their economic impact in Holstein cows. Czech Journal of Animal Science 64:107-117.

Contributed papers or abstracts research and extension

1 Li, M, V. E. Cabrera, and K. Reed. 2019. Updating Holstein and Jersey lactation curve parameters for the Rumination Farm System Model (RuFaS). Journal of Dairy Science 102: (Suppl. 1): M128.

2 Li, W., and V. E. Cabrera. 2019. Interactions among pregnancy rate, turnover ratio, and herd structure. Journal of Dairy Science 102: (Suppl. 1): M131.

3 Delgado, H., L. Fadul-Pacheco, and V. E. Cabrera. 2019. The use of integrated data to identify first-lactation cows at high risk of clinical mastitis. Journal of Dairy Science 102: (Suppl. 1): M134.

4 Fadul-Pacheco, L., H. Delgado, and V. E. Cabrera. 2019. Machine learning algorithms for early prediction of clinical mastitis. Journal of Dairy Science 102: (Suppl. 1): 94.

5 Li, M., V. E. Cabrera, and K. Reed. 2019. A stochastic animal life-cycle simulation model and its herd structure. Journal of Dairy Science 102: (Suppl. 1): 96.

6 J. Barrientos-Blanco, V. E. Cabrera, and R. D. Shaver. 2019. Executing a better nutritional grouping strategy in commercial dairy farms. Journal of Dairy Science 102: (Suppl. 1): 98.

7 Bellingeri, A., A. Gallo, D. Liang, F. Masoero, and V. E. Cabrera. 2019. Development of a decision support tool for optimal allocation of nutritional resources in a dairy herd. Journal of Dairy Science 102: (Suppl. 1): 100.

8 Li, W., and V. E. Cabrera. 2019. Economics of using beef semen. Journal of Dairy Science 102: (Suppl. 1): 102.

9 Cabrera, V. E., J. Barrientos, L. Fadul, and H. Delgado. 2019. Real-time continuous decision-making using big data. Journal of Dairy Science 102: (Suppl. 1): 322.

10 Mur-Novales, R., P. M. Fricke, V. E. Cabrera, J. O. Giordano, M. C. Wiltbank, and J. P. N. Martins. 2019. Effects of parity, season and region on fertility of lactating dairy cows submitted to a Double-Ovsynch protocol for first timed-AI. Journal of Dairy Science 102: (Suppl. 1): W110.

11 Ricci, A., M. Li, P. M. Fricke, and V. E. Cabrera. 2019. The reproductive and economic impact among 6 reproductive programs for lactating dairy cows including a sensitivity analysis of the cost of hormonal treatments. Journal of Dairy Science 102: (Suppl. 1): W115.

12 Skevas, T., and V. E. Cabrera. Spatial dependence and dynamic productivity growth in Wisconsin dairy farming. Selected Paper prepared for presentation at the 2019

Agricultural & Applied Economics Association Annual Meeting, Atlanta, GA, July 21 – 23.

13 Njuki, E., B. Bravo-Ureta, and V. E. Cabrera. 2019. Productivity, weather and climate: Evidence for a sample of Wisconsin dairy farms from a GTRE model. Asociación Española de Economía Agraria, XII Congreso de Economía Agraria, Lugo, Galicia, September 5, 2019.

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

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, profitability, and environmental performance 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., K. Reed, F. Ferreira, C. Nicholson, G. Thoma, J. Grabber, and 14 other key personnel. 2020-2025. Developing systems technology, education, and consumer confidence for the dairy industry of the future. USDA NIFA Sustainable Agricultural Systems - Coordinated Agricultural Project. $10,000,000. *Pending*.

Cabrera, **V. E.,** K. Weigel, H. White, M. Ferris, M. Livny, J. Patel. 2019-2022. Developing a Virtual Dairy Farm Brain: The Next Big Leap in Dairy Farm Management Using Coordinated Data Ecosystems. USDA National Institute of Food and Agriculture, Food and Agriculture Cyberinformatics Tools (FACT) Initiative. Grant N0: 2019-68017-29935. $1,000,000.

Cabrera, **V. E.,** K. Weigel, H. White, M. Ferris, M. Livny, J. Patel. 2017-2019. A virtual dairy farm brain. University of Wisconsin-Madison 20/20 Competitive Initiative. $500,000.

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.