-MINUTES-

NC-1042 Annual Meeting Agenda

October 13-15, 2011, University of Maryland 4-H Center

Participants:

Jud Heinrichs, Andre Brito, Paul Kononoff, Jeffrey Bewley, Stephanie Hill Ward, Lisa Holden, Peter Erickson (President), Victor Cabrera (Secretary), Ken Kalscheur, Allen Young, Hugh Chester-Jones, Cathleen Williams, David Beede, Albert De Vries, Boris Bravo-Ureta, Tamilee Nennich, Robert Peters (Host), David Benfield (Administrative Advisor), Rossi (Peter Erickson's PhD Student).

Invited Speakers:

Mark Mirando and Steve Smith (USDA National Program Leaders)

Adel Shirmohammadi (Dean and Director of MAES, University of Maryland)

Rick Kohn (Researcher University of Maryland)

October 13

Peter Erickson (President): call to order

Robert Peters (Host): Housekeeping

Adel Shirmohammadi welcomed the group.

Steve Smith and Mark Mirando (USDA NPL) gave a Washing ton update

- NIFA mission: land food and agriculture for better future for US and the world
- Dr. Catherine Woteki sworn Oct. 4: Good no surprise… nice choice
- Dr. Chavonda Jacobs-Young acting director (replacing Dr. Beachy who resigned on May 20, 2011)
- Focus, scale and impact-overarching themes
- Refocusing NIFA: climate change, bioenergy, food safety, nutrition and obesity, global food security
- 2 deputy directors career level executive. Four institutes, multi-disciplinary outcome based each one with principal scientist
- Re-organization to optimize serve stakeholders and elevate standing agricultural sciences
- Re-organization: outcome based, effectively integrate research, extension and instruction
- NIFA: lead scientists + effective administrators, seek external advice
- Office director: 6 institutes: NIFA structure

- Each institute has its own mission…
- Also center for international programs… to developing countries
- GRANTS: Mark Mirando, RFAs that have been released: in handout, 7 in 2011
- Foundational programs: fundamental basic
- Childhood food safety, global food security and sustainable Bioenergy
- Next year probably around same programs
- Animal opportunities: Foundational programs: 4 animal breeding, reproduction, nutrition, health and wellbeing! Research basic: limited to 500K; Food safety: large integrated salmonella and other microorganism; climate change: adaptation and amelioration in animal production… combination with forage and forestry computing same funds (2010-poultry and swine, 2011-large ruminant, 2012-small ruminant and minor species… but based on stakeholders focus not narrowed); global food security: translational genomics for disease resistance 600K x 5 yr, extension driven disease prevention in animals; translational genomics to improve reproduction in animals all these last three are integrated… some of these require 2 components, for example in the last one required extension and research. Instruction could be, but not required.
- Joint opportunity: dual purpose with dual benefit: NIFA & NIH, research biomedicine and agriculture using agriculturally important domestic species: reproductive technologies, obesity, use animals to do work applicable to animals and humans: 4 components: 1 scientific knowledge areas in RFA, focus on problems similar human health and animal agriculture, applicable human and animal. Standing announcement (PAR-10276) submitted to NIH, Mark Mirando program contact: Sept 20 2011, 2012. Predominantly animal science departments and vet schools submissions: NIH funded a few and AFRI there few: more people to have not submitted before to NIH to do so… advertisement for NIH… other thing panel from animal sciences to NIH. NIFA 5 million committed each year: NIH no any amount committed they found all that are above 11 percentile, not set aside
- Another joint opportunity NFA, NSF, NIH, and UK: ecology and evolution of infectious disease: more info Peter Johnson. NIFA 2.5 million December 7, 2011 deadline (first Wednesday in Dec in next years.
- Member of multi state projects great way to collaborate and suggest to look RFAs.
- Brand new opportunity: NRSP-9 National animal nutrition program: address gaps and priority issues associated with animal nutrition, ensure recommendations of requirements are continually updates: commutes: coordinating animal nutrition issues, modeling, feed composition: not intended to support research, is for meeting: strong working partnership with NRC 175K with matching expected, instructions to be distributed by Oct 31.
- Most useful link is last page in handout: NPL contact information.
- Funds: another handout: encourage to lobby: let your legislator your priorities are. Opportunity for them also to influence where the money goes. Change a program needs normally takes stakeholders input.

David Benfield (Administrative Advisor)

- Apologize not being last 2 years meetings. He was traveling.
- NRSP-9: competitive selecting process: he will send add info. Application and selected process. Coming out.
- Hatch and NIFA: lots of things going on behind scenes: to have formula (base) funding… Crucial funding for experimental stations. Large institutions are not opposed to rely more on competitive, opposite small experimental stations. Budget Advocacy group: Discussion consolidating as NIH and NSF to one line. All institutions were lobbying group: if not increase, at least to keep to base as previously. If there is an increase, how to do it: 70 to 30% competitive and base. 55 vs 45% would not fly well in congress that they want more competitive. All in discussion now with directors and deans and USDA: go forward to a plan to increase funds up to $750M.
- Project re-write: 1 year extension Sept 30 2013 (official now)… Goal this and next year to re-write. First decision: re-write? Or end the project. Hand out APPENDIX N-1, deadlines: Dave willing and glad to continue to be the Administrative Advisor. December 15 2012 deadline: better to give to him in November to have time to review and comment. If retain same objectives: justify why they remain why they were not completed. Impacts: are crucial for committee. Crucial as well the progress from previous project: emphasize collective group achievements because is a multi-state proposal. Sure to incite how much leverage you got in grants. Guidelines have changed: 15 pages, but is the number of characters… so 22-23 pages… on the web. Take redundancies out of the proposals. Need a writing committee: somebody for each section… point person for each part. Participation: we cannot exclude anyone to participate from outside… its going to be public… but careful from those who actually do not participate.
- Victor Cabrera (Secretary) to send David Benfield list of those who are in Appendix E who haven't send report or are not attending. He will inform the directors in their respective universities.
- Impact statements: document in OSU that Dave will send to the group. Good idea to have the objectives previous in hand.

Stations Reports

- PA (Jud and Lisa)
- LA (Cathleen)
- MS (Stephanie)

Rick Kohn (Invited Speaker), Department of Animal and Avian Science, U Maryland: Using milk urea and blood urea to evaluate animal nutrition and estimate nitrogen excretion.

Stations Reports

- UT (Allen)
- SD (Ken)
- IN (Tamilee)
- MD (Bob)
- NH (Peter & Andre)
- MI (Dave)

October 14

Stations Reports

- FL (Albert)
- WI (Victor)
- CT (Boris)
- KY (Jeffrey)
- NE (Paul)
- MN (Hugh)

Project Re-Write

- Discussion
    - Jud-Seems equally divided objects and people working
    - Boris-critical cross collaboration… something unified work, strength it… that could be helpful if a RFP comes around
    - Albert-spend more time discussing collaborative work, rather than just report
    - Boris-Maybe breakout in sessions: get more in depth
    - David Benfield-how to re-structure the objectives and how these at the end will come together in a one unified proposal
    - Peter-3 groups split and come out with a re-defined objectives
    - Dave-It could be word-by-word same objectives, but it should be justified
    - Jeffery-Add obj. 2 some well-being
    - David Benfield-How to put data/analysis together to give to the industry… software that could be linked
    - Jud-software development too in reports
    - Paul-Something to the nutrition meetings… maybe a session or printed material: Documenting this work…
    - Jud-maybe impact statement what meetings you have talked too… summarize that would be good

- Jeffrey-something to the extension audiences…newsletters… maybe some of those are already done
- Jud-How many pubs are in the eXtension
- Ken-JDS or something
- Victor-Send to the group NETWORK of impact of publications of authors and relationships
- David Benfield- there is a need to do termination report anyway 4 or 5 year termination report… for the whole project
- Jud-ARPAS could be an outlet for doing a review, like a review article

Re-Write: Project Title Change and Objective Groups Outcomes

- Overall Title: "**Strategies to improve economic and environmental sustainability of dairy enterprises**"
- Obj. 1: "**to improve heifer performance by increased understanding of feeding strategies, management systems, well-being, and overall productivity.**" Committee: Peter, Hugh, and Andre.
- Obj. 2: "**Improve management decisions related to dairy cows ton enhanced well-being, nutrient utilization, and profitability."** Committee: Paul, Ken, and Andre.
- Obj. 3: **"To evaluate the profitably and environmental sustainability of dairy farm enterprises."**
    1. Evaluate adaptations of dairy cattle to their physical environment and farm management implications,
    2. Documenting seasonality of farm systems,
    3. Cost of production analyses across states and over time, and
    4. Use the IFSM as a platform to share and analyze whole farm systems.

  Committee: Victor, Albert, Boris, Jeffrey, Lisa, Bob.

Business Meeting

3.55 pm: Call to order Peter

- Approval of 2010 meeting minutes: Bob second Allen. Approved unanimously.

Committee reports:

- Tamilee: Organized in March 2010 Des Moines Symposium in the Midwest ADSA meeting: Albert, Jeffrey, and Victor from project presented in invited session.
- Tamilee: Organizing Applied Technology session in Midwest ADSA meeting next 2012 March with some project speakers.

Location for 2012 meeting:

- Hugh: Michigan (Dave told Hugh would be good idea)
- Peter: Cathy Williams would also be option she offered but concerned about farm visits
- Michigan approved. David Beede will be glad to make the arrangements to host us in MSU next year.
- Dates: October 11-13, 2012. Approved.

Election for Secretary

- Andre Brito (proposed by Boris) for secretary 2011-2012. Unanimously elected. He accepted.

Other Business

- Hugh: Motion to thanks Bob for all arrangements and graciously hosting the meeting this year. Unanimously recognized.
- Hugh: Motion to adjourn the meeting, Boris seconded.

-ANNUAL REPORT-

1. WORK PROGRESS AND PRINCIPAL ACCOMPLISHMENTS

A. PROJECT OBJECTIVE 1 (HEIFERS)

Further studies on pasteurized colostrum feeding for newborn dairy calves

Research at Penn State and the University of Minnesota has previously demonstrated the potential of improving IgG absorption from bovine colostrum with the process of heat treating (pasteurization). Our published papers and those from researchers from The University of Minnesota College of Veterinary Medicine have shown that heating colostrum at 60^0C for 30 to 60 minutes successfully decreases bacteria numbers, does not affect viscosity or IgG level, yet improves the absorption of the active IgG molecule into the blood stream of the neonate bovine animal by an average of 26% more IgG absorption. To date 5 studies have been published, and all of them using high quality colostrum only. We propose to study a broader range of acceptable colostrum quality (based on IgG level) to further delineate the effects of this heat treatment on the range of bovine colostrum samples commonly found on dairy farms. This research will involve feeding 60 neonate bovine calves either heat treated or control colostrum (first feeding) to further delineate the impacts of this management practice on IgG absorption in the calf from first colostrum feeding.

Fiber effect on rumen development in pre-weaned calves

Dairy calves are born with an undeveloped digestive system, and have to transition from simple stomach digestion to ruminant digestion. Weaning is the final step of this transition, and likely is the most stressful period in the calves live. However, weaning can be less stressful if the calf's digestive system is ready to acquire all the nutrients from solid feed only. Calves are born with no rumen papillae, but develop papillae through the absorption of butyric and propionic acid, end products of fermentation in the rumen. Rumen papillae development, in terms of size and appearance, can be analyzed to help determine the digestive system development. Grain promotes more of a propionic and butyric fermentation as compared to forage, which promotes more of an acetic fermentation. Current recommendations for feeding young calves do not include forage in the ration. However, lack of forage (or effective fiber) may promote a more acidic environment in the rumen which has been shown to result in keratinization of papillae. In a previous experiment done in our lab, rumen papillae of calves fed milk + grain only, were short (underdeveloped) and had signs of keratinization. The results from the current experiment will help to determine if providing forage to pre-weaned calves can improve the development of the young calf's digestive system. This could further aid in improving management practices and feeding systems at the farm level. Holstein bull calves (n = 15) will enter the study at 2 d of age, and will be randomly assigned to treatments, milk + grain, milk + grain + hay, or milk + hay + corn silage. Housing will be at the outside housing area of the calf barn, in the Penn State Dairy Barns. Rubber mats will be used instead of straw or shavings as is often used for bedding. Any straw or shavings that the calves might consume would confound the study. Rubber mats will be cleaned daily by the researchers. Milk and water will be offered following dairy barn management protocol. Grain will be offered free of choice by researchers who will also monitor its intake. Grass hay will be sieved in the ASABE particle separator, with particles retained on

the top sieve and pan discharged. Researchers will be responsible for hay and corn silage feeding, corn silage will be fed daily and grass hay as needed. Calf health will be monitored daily until weaning age (5 weeks). Blood will be collected weekly for IgG levels analysis. At weaning age, calves will be taken to the Penn State Meats Lab where they will be euthanized, and the digestive system harvested to determine its health and development.

Verification of weight tapes for dairy heifers

Using data from several NC 1042 Stations, we are developing a revised Holstein Weight (Heart Girth) Tape for use by dairy farmers and advisors to estimate the weight of dairy heifers. Since these heart girth comparisons are based on body conformation, as genetics change (in addition to breed) the equations may need to be subtly revised. The current analysis is including other data in addition to actual weight and heart girth, which have the potential to make the weight tapes to be more accurate in estimating body weight of the growing heifer. Data has been received for 3 stations to date and more is expected.

Feeding Different Quality of Forage and Protein Degradability on Nutrient Utilization in Dairy Heifers

This study is being done to determine the effects of manipulating the degradability of the protein fractions in heifers diets containing two dietary fiber quality levels with four combinations of rumen degradable protein (RDP) and rumen un-degradable protein (RUP). Our previous data suggest that forage utilization of the diet of heifers can be manipulated with different responses expected as the forage quality and degradability of the protein fraction of the diet changes. Therefore it is necessary asses the level that RDP to maximize microbial protein synthesis and animal performance when dairy heifers are limit-fed an optimal N and ME intake. Eight Holstein ruminally cannulated heifers of approximately12-13 months of age at the beginning of the experiment will be randomly assigned to 2 forage types: High Quality (HQ) and Low quality (LC) fed at 80+% of the total diet DM. Diets within forage quality will be formulated to vary the degree of rumen protein degradability (RDP) maintaining the same level of N/kg of $BW^{0.75}$ that has been observed to enhance N utilization in dairy heifers (Zanton and Heinrichs, 2009). Specifically, heifers will be offered a basal diet containing LQ or HQ forages and a RDP type sequence (52, 60, 68, and 76% RDP, %CP) within forage quality administered according to a split-plot, 4×4 Latin square design (21-d periods). All diets provided similar intakes of ME and allowed 800 g/d of ADG. Feces and urine will be collected from d 14-19 (5 days of total collection). Urine will be collected through the use of a modified urine cup collection method. Rumen fluid will be sampled on day 20-21 to determine the profile of rumen ammonia, AA, and volatile fatty acids. Additional rumen samples will be collected for nutrient, bacterial, and protozoa analysis. Rumen evacuations will be done twice during the collection week to determine total rumen content.

Performance of post weaned Holstein heifers fed a grain mix with free choice hay or a total mixed ration (TMR) containing sweet corn cannery waste, hay and dried distillers' grain.

Two consecutive studies were conducted to evaluate post weaned heifer performance when fed TMR diets containing sweet corn cannery waste (SCCW), hay and dried distillers grains

(DDGS). In study 1, 112 four-month old Holstein heifers (av.136.5±1.03 kg) were assigned to 1 of 8 pens (7 heifers/pen) and 1 of 2treatments for 56 d. Treatments included: 1) Control 16% CP grain mix fed at 2.27 kg/hd daily with free choice (FC) hay; 2) Free choice ensiled TMR (33% SCCW, 33% hay, 33% DDGS, DM basis) top-dressed with 0.75 kg protein pellet at feeding. Heifers fed the TMR had higher ($P < 0.05$) ADG (1.2 vs. 0.98 kg/d), hip height gain (+1.22 cm), body condition score change (+ 0.44), and gain/feed (0.23 vs. 0.17 kg BW/kg DMI) compared to those fed the control diet. For study 2, dietary composition of the TMR was modified to reduce heifer gain to approximately 1 kg/d and 126 three-month old Holstein heifers (av. 114.3± 0.93 kg) were assigned to 1 of 6 pens (7 heifers/pen) and 1 of 3 treatments for 84 d. Treatments included: 1) Control 16% CP grain mix fed at 2.27 kg/hd daily with FC hay; 2) Free choice ensiled TMR (40% SCCW, 28% hay, 32%% DDGS, DM basis) top-dressed with 0.14 kg mineral mix at feeding; 3) Ensiled SCCW mixed daily with hay and distillers grains (40% SCCW, 28% hay, 32%% DDGS, DM basis) top-dressed with 0.14 kg mineral mix at feeding. Heifers fed the TMR diets had higher ($P < 0.05$) ADG (1.05 vs.0.93 kg/d), hip height gain (14.1 vs. 13.1 cm), BCS change (+ 0.87 vs. + 0.77) and gain/feed (0.28 vs. 0.22 kg BW/kg DMI) than those fed the control diet. Heifers fed the TMR diets performed similarly but a higher refusal rate was evident when the TMR was mixed daily. Under the conditions of these studies preparing a complete SCCW, hay and DDGS ensiled TMR or mixing a TMR daily with individual ingredients offers a lower cost alternative feed for post weaned heifers from 3 to 6 months of age compared to limit feeding a grain mix with FC hay.

Pre- and post-weaning performance and health of dairy heifer calves fed calf starters and grain mixes with glycerol as a replacement for corn.

In phase 1, one-hundred-twenty (2-4 d old) individually fed Holstein heifer calves (40.3 ± 0.08 kg BW) were randomly assigned to 1 of 4 treatments for a 56-d nursery study to evaluate the use of glycerol as a replacement for corn in calf starters (CS) and its impact on performance and health pre-(d 1-42) and post-weaning (d 43-56). Treatments were: 1) Complete texturized 18% CP control CS (CON); 2) Complete pellet 18% CP control CS (CONP); 3) 18% CP pelleted CS containing 3% glycerin (27.3 kg/ton; 3%GLY) and 4)18% CP pelleted CS containing 6% glycerin (54.6 kg/ton; 6%GLY). All calves were fed a 20:20 (CP:fat) milk replacer, at 0.28 kg/d powder in 2 L water 2 X daily from d 1 to 35 once daily from d 36 to 42 weaning. There were no treatment differences ($P > 0.05$) in pre- and post-weaning calf performance. Average daily gain and feed/gain for the nursery phase were 0.61 and 1.88 kg for d 1 to 56, respectively. Health treatment costs were highest ($P < 0.05$) for calves on 6%GLY. Calves were transitioned to group pens and fed the CON CS for 7 days. One-hundred-five calves (av. 84.7±0.71 kg) from the nursery phase were then re-assigned to 5 replicated pens (7 calves/pen) each of 3 limit-fed grain mixes with free choice hay for a 112-d study. Treatments included: 1) 16% CP corn and pellet grain mix fed at 2.73 kg/hd daily for 56 days and 2.27 kg/hd daily from 57 to 84 days; 2) 16% CP corn and pellet mix with 3% added glycerol fed as in 1; and 3), 16% CP corn and pellet mix with 6% added glycerol fed as in 1 and 2. From d 85 to 112 all group pens were fed a common 16% CP grain mix at 2.27 kg/hd daily with free choice hay. There were no overall treatment effects on calf ADG or feed/gain ($P > 0.05$) averaging 1.04 and 4.39 kg respectively. Hay intake was lowest ($P = 0.02$) for calves fed the grain mixes with glycerol. Under conditions of this study, glycerol can be used as an alternative energy source as partial replacement for corn in CS or grain mix formulations.

Impact of free-choice or restricted water intake during the pre-weaning and early post-weaning period on calf performance and health.

Two studies were conducted to compare the impact of free choice versus restricted water intake during the milk replacer (MR) feeding period and 2 wk following weaning on calf performance. Study 1 was conducted spring of 2009 and study 2, summer of 2010. A total of 114 (study 1= 44; study 2 = 70) 2 to 4 d old Holstein calves were assigned to 1 of 2 treatments: 1) Free choice water intake for 56 d (CON) or 2) Restricted water intake (RW). The RW treatment was no water available the first 36 d of the study followed by limited amount offered (2.3 kg/d) d 36 to 42 and free choice d 42 to 56. All calves were fed 0.28 kg of a 20:20 MR powder in 2 kg water twice daily d 1 to 35 and once daily d 36 until weaning at 42 d. Medicated MR was utilized in study 1 and non-medicated MR in study 2. An 18% CP calf starter (CS) was offered free choice d 1 to 56. Water, MR and CS intakes along with fecal scores were recorded daily. Body weight (BW) was measured d 1, 14, 28, 42 and 56 and hip height d 1 and 56. Data were analyzed as repeated measures using the PROC MIXED procedures of SAS. Study was included in the model as a blocking factor and initial BW was used as a covariate. During the MR feeding period (d 1-42), CON calves in study 1 and 2 consumed more water ($P < 0.05$) per d than the RW calves (study 1 = 0.54 vs. 0.22 kg/d; study 2 = 1.9 vs. 0.34 kg/d). Due to differences in season between studies, CON calves in study 2 consumed 1.4 kg more water per d than CON calves in study 1 from d 1 to 42 ($P < 0.05$). Average daily water intake from d 1 to 56 was similar for calves on the CON and RW treatment in study 1 averaging 1.6 kg water/d, but in study 2, CON calves consumed 1.0 kg more water per d ($P < 0.05$) compared to RW calves (2.9 vs. 1.9 kg/d). In both studies, differences in water intake between CON and RW treatments did not affect daily gain, CS or total dry matter from d 1 to 42 or d 1 to 56. Across studies, overall CS intake, total DM intake and daily gain averaged 0.66, 0.91, and 0.55 kg/d, respectively. Under conditions of these studies restricting water intake in the first 42 d did not affect calf performance.

Effect of enhanced feeding rates of conventional milk replacer on pre- and post-weaning performance and health of dairy calves.

Holstein heifer calves [n = 100, 2–4 d old, average bodyweight (BW) = 39.9 kg] were used in an experiment to evaluate the effects of enhanced (ENH) feeding rates of conventional milk replacer (MR) on calf growth, starter intake, and health during pre- (d 1–42) and postweaning (d 43–56) periods. Calves were housed in individual calf pens within a naturally ventilated barn with curtain sidewalls. All calves were fed a 20% CP, 20% fat all-milk MR reconstituted to 15% solids, an 18% CP (as-fed basis) texturized calf starter and free-choice water.Calves were assigned randomly to 1 of 4 treatments: 1) 0.57 kg/d (asfed MR powder weight) d 1–35 and 0.28 kg/d d 36–42 (CON), 2) 0.68 kg/d d 1–21, 0.45 kg/d d 21–35 and 0.23 kg/d d 36–42 (ENH21), 3) 0.68 kg/d d 1–28, 0.45 kg/d d 28–35 and 0.23 kg/d d 36–42 (ENH28), and 4) 0.68 kg/d d 1–35 and 0.34 kg/d d 36–42 (ENH35). Calf BW on d 56 was greater ($P < 0.05$) for ENH35 (79.2 kg) and ENH28 (78.5 kg) calves compared with CON (75.1 kg), whereas BW of ENH21 (76.6 kg) calves did not differ from CON. Average daily gain from d 1–56 tended to be greater ($P = 0.10$) for ENH35 (0.70 kg/d) than for CON (0.63 kg/d) calves, with ENH21 (0.65 kg/d) and ENH28 (0.69 kg/d) calves having intermediate growth rates. Frame growth from d 1–56 also differed due to treatment; ENH35 (10.5 cm) and ENH28 (9.91 cm) calves had greater ($P < 0.05$) hip height gain than CON (8.81 cm), while ENH21 (9.47 cm) calves had similar changes in

frame growth compared with CON. Coinciding with decreased MR intake, calves on the ENH21 treatment had greater ($P < 0.05$) starter intake from d 22–35 compared with ENH35, whereas ENH28 calves consumed more ($P < 0.05$) starter than ENH35 calves from d 29–35. Overall, starter intake from d 1–42 and 1–56 did not differ ($P > 0.10$) among treatment. Total MR intake (as-fed) was 22.6, 22.9, 24.5, and 26.6 kg/calf for CON, ENH21, ENH28, and ENH35, respectively. Health parameters did not differ among treatments. Compared with CON, feeding ENH rates of a conventional MR (0.68 kg/d) for at least 28 d increased d 56 BW and d 1–56 hip height gain without affecting starter intake.

Effect of feeding duration on growth of group fed dairy calves during transition to an organic production system.

Heifer calves (n=61) were used to evaluate the effect of early life feeding duration in a group management system on body weight and hip height. Calves were assigned to feeding groups of 10 in super hutches by birth order, and were born at the University of Minnesota West Central Research and Outreach Center, Morris, Minnesota from March to June 2010. Breed groups of calves were: Holsteins (n=9) selected for high production (HO), Holsteins (n=14) maintained at 1964 breed average level (H64), crossbreds (n=28) including combinations HO, Montbeliarde, and Swedish Red selected for high production (HMS), and crossbreds (n=10) including combinations of HO, Jersey, and Swedish Red selected for durability (HJS). Early weaning (EW) groups were fed 1.5% of birth weight 13% total solids organic milk once daily until the youngest calf in the group was 4 weeks old, reduced to 0.75% of birth weight for 1 week, and then weaned when the group consumption averaged 0.91 kg starter/calf/day. Late weaning (LW) groups were fed 1.5% of birth weight of organic milk once daily, and then weaned when the group consumed 0.91 kg of starter/calf/day, and the youngest calf in the groups was 9 weeks old. Body weight and hip height were recorded at birth, weaning, and day 90 and 120. Independent variables for statistical analysis were the fixed effects of weaning group (EW or LW) and breed group. Weaning group performance was weaning age (days), EW (44.6) vs. LW (63.6) ($P<0.01$); gain per day (kg), EW (0.42) vs. LW (0.59) ($P<0.01$); weaning weight (kg), EW (56.4) vs. LW (73.5), ($P<0.01$); weaning hip height (cm), EW (83.3) vs. LW (90.4) ($P<0.01$); 90-d weight (kg), EW (91.1) vs. LW (99.7) ($P<0.05$); and 120-d weight (kg), EW (113.3) vs. LW (118.5) ($P>0.25$). The HO (0.51; 67.2), H64 (0.44; 60.8), HMS (0.54; 69.4), and HJS (0.53; 62.3) calves were not significantly different for gain per day (kg) or weaning weight (kg), respectively. In summary, EW calves had less body weight and hip height compared to LW calves during organic transition.

Group feeding calves for an organic dairy production system.

The maintenance of health and growth of organic dairy calves is very important in their first few months of life. As no organic milk replacers are available, whole milk from high somatic cell organic cows, as well as bulk tank milk, must be fed. The cost versus benefits of milk consumption and weaning age is very important and has not been researched with organic dairy

calves. Therefore, our objective was to evaluate the growth, health, and most importantly, the economic performance of organic dairy calves fed once per day and weaned at different ages. Heifer calves (n=67) were assigned to feeding groups of 10 in super hutches by birth order, and were born at the University of Minnesota West Central Research and Outreach Center, Morris, Minnesota from March to June 2011. Breed groups of calves were: Holsteins (n=11) selected for high production (HO), Holsteins (n=10) maintained at 1964 breed average level (H64), crossbreds (n=28) including combinations HO, Montbeliarde, and Swedish Red selected for high production (HMS), and crossbreds (n=18) including combinations of HO, Jersey, and Swedish Red selected for durability (HJS). Calves were weaned at 30, 60, or 90 days of age, and groups were fed 1.5% of birth weight of 13% total solids organic milk once daily and weaned when the group consumption averaged 0.91 kg of starter/calf/day. Body weight was recorded at birth and at weaning. Analysis was with PROC GLM of SAS, and independent variables were weaning group and breed. Average daily gain (kg) was 0.52±0.03, 0.68±0.02, and 0.75±0.02 for the 30, 60, and 90-d weaning groups, respectively. Total costs (grain and organic milk) to weaning were $108.81±7.70 for 30-d, $167.68±5.83 for 60-d, and $275.79±6.85 for 90-d groups; however, the cost per pound of gain was higher for the 30-d group than the 60-d or 90-d groups. The average daily gain (kg) for breed groups was: HO (0.72±0.03), H64 (0.61±0.03), HMS (0.67±0.02), and HJS (0.60±0.03). Take home message: Late weaned calves grew faster than early weaned calves; however, the optimum time for weaning of organic dairy calves may be between 30 and 90 days. Successful group feeding of organic dairy calves is enhanced with aggressive suckling during infancy and early consumption of high quality organic calf starter.

Evaluation of dietary fat from dried distillers grains in the diet Holstein heifers on growth and dry matter intake.

The objective of this study was to determine how increased dietary fat from dried distillers grains with solubles (DDGS) in diets of growing heifers affects DMI, ADG, and growth. Thirty-three Holstein heifers (133 ± 18 d old) were used in a 24-wk randomized complete block design. Treatments were: 1) control (C) containing ground corn (15.9% of DM) and soybean products (17.9%), 2) low-fat (LF) containing low-fat, high-protein DDGS (21.9%) and ground corn (11.9%), and 3) high-fat (HF) with traditional DDGS (33.8%). All diets contained 39.8% grass hay, 24.8% corn silage, and 1.5% vitamins and minerals. Diets were formulated for 16.3% CP (DM basis) 9.8% RDP and 6.5% RUP. The HF diet contained 4.8% fat compared to 2.8% in the C and LF diets, which were greater in NFC. Diets were 1.0 Mcal/kg of DM and limit-fed at 2.45% of BW. Heifers were weighed every 2 wk and rations adjusted accordingly. Every 2 wk, heart girth, hip height, wither height, body length, and BCS were recorded. No treatment × time interactions were found. DMI were similar, averaging 7.01, 7.01 and 6.89 kg/d (SEM=0.26) for C, LF, and HF, respectively. BW were similar among treatments (248.4, 243.9, 244.2 kg, SEM=8.06), as were ADG (0.92, 0.90, 0.91 kg/d, SEM=0.07). Heart girth was similar among treatments (137.7, 138.2, 144.7 cm, SEM=3.51). Hip height was less ($P<0.01$) for heifers fed HF (118.3 cm) 2 compared to those fed C (119.7) and LF (119.3, SEM=1.18). Wither height was greater ($P=0.02$) for heifers fed LF (115.3 cm) compared to HF (114.4), and tended ($P=0.09$) to be greater compared to heifers fed C (114.6), but C and HF were similar (SEM=1.01). Body

length was longest (P<0.01) for heifers fed C (105.0 cm), shortest for HF (102.6), with LF (103.7) in between (SEM=1.47). Overall BCS were similar for heifers fed C and LF (3.05), but greater (P=0.04) for HF (3.09, SEM=0.02). Despite similar BW, ADG, and DMI, feeding diets with additional fat from including DDGS compared to diets with lowfat DDGS or corn and soybean products to growing heifers may result in slightly greater BCS and slightly smaller body frame sizes.

Effects of resistant starch in milk replacer on health and performance of neonatal Holstein heifer calves.

Forty-two female Holstein calves were assigned to one of three treatments at d 2 of age to study the effects of adding resistant starch (RS) to the milk replacer on health and performance. Treatments were control (C) (no RS), 4g RS (low; L), and 8g RS (high; H) mixed into the reconstituted replacer. Calves were housed in individual calf hutches and fed milk replacer once daily until d 42 of age. A 18% crude protein calf starter and water were offered ad libitum beginning d 3 throughout the duration of the trial. Calves remained in their hutches until 56 d of age to determine immediate postweaning performance. Body weights were measured at birth and d 14, 28, 42, and 56 of age. Wither height (WH), hip height (HH), and hip width (HW) were measured on d 14, 28, 42 and 56 of age. Feed intake and fecal scores were recorded once daily through d 56. At 24h of age blood was collected for determination of serum Immunoglobulin G (IgG) concentration. On d 14, 28, 42, and 56, fecal samples were collected for analysis of pH and volatile fatty acids (VFA), and blood was collected for analysis of plasma urea nitrogen (PUN) and total protein (TP). IgG concentrations were > 10 mg/dl for all calves. PUN and TP did not differ (P > 0.05) and were within normal ranges suggesting that there were no major metabolic problems. There was no effect (P < 0.05) of treatment on body weight, HH, HW, WH, or body temperatures. There was a treatment by week interaction (P<0.01) and a week effect (P<0.01) for grain intake, with all calves increasing intake throughout the duration of the study. There was a treatment by week interaction (P<0.01) and a week effect (P<0.01) for fecal scores, with calves having lower fecal scores at the end of the study compared to the beginning. There was an effect of treatment (P<0.05) on fecal pH with calves fed 8 g resistant starch having the lowest fecal pH. Fecal pH increased with age (P < 0.05) and were not different at 6 weeks of age. There was a treatment by week interaction (P<0.05) with an effect of both week (P<0.01) and treatment (P<0.05) for propionate concentrations in the feces. There was an effect of week (P<0.01) for acetate and butyrate concentrations as well as total VFA concentration in the feces. Overall, incorporation of RS in the milk replacer of neonatal dairy calves did not show any significant effects on growth or gut health of Holstein dairy calves. However, changes in fecal pH and short chain fatty acids at weeks 2 and 4 may indicate that resistant starch had a few favorable effects on fermentation in the large intestine.

Effects of shade on heat stress reduction in Holstein dairy calves

Heat stress, a particular concern to southern dairy producers, can cause a variety of homeostatic alterations that can inhibit optimal calf development and prohibit full production potential. Therefore the objective of this study was to determine the effect of shade on performance and metabolic indicators of heat stress in neonatal dairy calves. Sixteen (n=16) neonatal Holstein heifers were assigned to either a non-shaded (NS) or shaded (SS) hutch for an 8 week period. Rectal temperatures, surface temperatures and respirations were measured at 0830 h and 1600 h 3 times per week. Average daily starter intake (ADI), water intake and fecal scores were

measured twice daily. Body weight, hip and wither height were measured at birth and at weeks 1, 2, 4, 6, and 8. Blood was collected at birth and then weekly for analysis of plasma urea nitrogen (PUN) and packed cell volume (PCV). As expected for a normal growing calf, ADI, body weight, hip height, and wither height increased ($P < 0.01$) with age while fecal scores decreased ($P < 0.05$) over time. However, there were no observable treatment effects ($P > 0.1$) on these parameters. Calves in NS hutches drank more ($P = 0.1$) water than shaded calves. Calves also drank more water ($P < 0.01$) as they aged. A treatment by time interaction ($P = 0.05$) was observed for rectal temperature, with afternoon measurements being higher in NS calves. A treatment by time interaction ($P < 0.01$) was also observed for surface temperature with lowest values in the SS calves in the morning. Likewise, there was a treatment by time interaction for respiration rates, with afternoon values for NS calves and morning values for SS calves being the highest. Surface temperature and respiration rates decreased ($P < 0.01$) as calves aged. There was no significant ($P > 0.1$) treatment effect on PUN, although PUN levels increased ($P < 0.05$) as calves aged. There was treatment by week interaction ($P < 0.05$) on PCV, with NS calves having greater values after week 3. While differences were observed in physiological parameters, there were no improvements in performance of these calves with addition of shade as a management practice.

Limit diets for heifers

Ninety-six Holstein heifers that included 9 fit with ruminal cannula were offered 1 of 3 diets for in a randomized replicated pen design. Dietary treatments included a control diet (C100), and two independent limit-fed (LF) diets. The LF diets included one offered at 85% of C100 intake (L85) without an ionophore, and a second containing an ionophore (325 mg/hd/d of lasalocid) that was offered at 80% of C100 intake (L80+I). Heifers were evaluated for growth, rumen digesta volume, nutrient excretion and subsequent lactation performance. Limit-fed heifers consumed less dry matter, neutral detergent fiber, and had greater respective ADG (0.96 or 0.89 vs. 0.81 kg/d), and lower feed:gain ratios (9.1 or 9.3 vs. 13.0 kg/kg) compared to heifers offered the C100 diet. No differences in rumen pH, NH3-N, or volatile fatty acid concentrations were observed between C100 and LF heifers. Rumen digesta volume, density, and weight were unaffected by LF, and feeding L85 or L80+I did not result in carryover effects for rumen digesta volume when these heifers were offered a common high fiber diet immediately after the 180-d growth trial. At parturition, no differences were observed for dystocia index, calf body weight or 7-d postpartum body weight between cows offered LF or C100 diets as heifers. Lactation body weight, dry matter intake (DMI), and feed efficiency of cows did not differ between treatments at 45 or 90 days in milk. Milk yield and milk components also were not different between cows that were offered C100 or LF diets as gravid heifers. Limit feeding of gravid Holstein heifers for 180 d did not result in any carryover effects during their first lactation for rumen digesta volume, DMI, or milk yield.

Phosphorus requirements for dairy heifers

The phosphorous (P) requirements for dairy heifers (0.20-0.35%) suggest that the need for supplemental P in dairy heifer diets may be minimal. Because long term studies are unavailable, 183 Holstein heifers and 182 backcross Holstein x Jersey heifers were fed diets with (SP = 0.38 % of dry matter (DM)) and without (NP = 0.28 % of DM) supplemental phosphorus from 4-22 mo of age in a replicated pen design. Heifers were evaluated for body weight (BW), external bone/frame growth, dystocia, calf BW, reproductive efficiency, and first lactation performance.

Heifers fed NP had similar ADG from 170-410 and 410-650 d of age as compared to heifers fed SP. At 22 mo of age, heifers fed NP did not differ in BW, hip height, hip width, body length, heart girth, cannon bone circumference or pelvic area as compared to heifers fed SP. As heifers, services per conception and age at pregnancy were not different between heifers fed NP or SP. At parturition, heifers fed NP or SP had similar dystocia scores and calves were similar in BW. Complete first lactation data (305 d) were available for 333 primiparous cows, and cows fed NP as heifers produced similar milk, fat, and protein as cows fed SP as heifers. Days open, days in milk at first breeding, and services per conception were also similar for primiparous cows fed NP or SP as heifers. Data suggest there was no growth, reproductive or lactation benefit to feeding dairy heifers diets containing 0.38 % P as compared to 0.28 % P.

Limited feed access feeding on dairy heifers

To assess effects of bunk access and limit feeding on dairy heifer growth and nutrient intake, 96 Holstein heifers were fed one of two diets, and allotted to full (F) or partial (P) bunk access. Pens (n=12) of heifers were limit fed a TMR without (NS) straw or fed a TMR with straw (S). Feed access times for NS and S were 6 and 24 h respectively. Heifers, fed NS or S, were assigned to pens with F (8 stalls/8 heifers) or P (4 stalls/8 heifers). Heifers were evaluated for growth, and nutrient intake. Bunk occupancy time and rate, 0-6 h post-feeding, were evaluated using timed digital photography. Bunk occupancy for F was longer (149.8 vs. 111.2 min) than heifers allotted to P. Feeding S (S vs. NS) increased heifer bunk occupancy by 16.2 min. Bunk occupancy rate was 27.6, 20.0, 24.4 and 18.1 min/h for FS, PS, FNS and PNS respectively. Dietary NDF increased 7.0 % units by feeding S and decreased DMI of heifers 0.28 kg/d as compared to limit feeding NS. Bunk access (F vs. P) had no effect on DMI or the intake of any nutrient. The ADG of heifers fed S or NS were similar (0.90 vs. 0.95 kg/d). Allotting heifers to F or P bunk access likewise had no effect on ADG (0.95 vs. 0.91 kg/d) and no interactions between bunk access and treatment diet on ADG were observed. Bionomical statistical evaluation however revealed that heifers limited to P bunk access were 2 times more likely to exceed or not meet ADG targets.

Addition of sodium bicarbonate to maternal colostrum. Effects on IgG absorption and hematocrit in neonatal calves.

The objectives of this experiment were to determine the effects of $NaHCO_3$ added to pooled maternal colostrum (PMC) on absorption of IgG and hematocrit in the neonatal calf. Previous research in our laboratory indicated that adding 30 g of sodium bicarbonate split between the first two feedings of colostrum replacer increased IgG concentration at 24 h of age (Morrill et al., 2010). However, when colostrum replacer was fed in one feeding, there was a linear response in reducing IgG uptake with added $NaHCO_3$ with most of the response due to the 45 g dosage (Cabral et al., 2011). Using 26 Holstein bull calves (43.8 +/- 6.1 kg), this study evaluated adding 30 g $NaHCO_3$ to PMC (82.1 +/- 8.45 g/L IgG). Total IgG fed was 330 +/- 34.6 g. Calves were fed in two feedings- at birth (2.68 L; within 75 min of birth) and another feeding 6 h later (1.32L). Calves received 2 L of milk replacer at 12, 24, 36, and 48h after birth. The pH measurements of the two treatments were: control 5.97 +/- 0.27 and 6.64 +/- 0.20 for $NaHCO_3$. Blood samples were taken prior to the first feeding of PMC (within 45 min of birth) and prior to feeding at 6, 12, 24 and 48h. Results indicated that there were no effects of treatment on 24 h serum IgG ($P = 0.55$; 32.6 g/L for control and 31.73 g/L for $NaHCO_3$), area under the curve (AUC) ($P = 0.29$; 1270 g/L × h for control and 1188 g/L × h for $NaHCO_3$), apparent efficiency

of absorption (AEA) (P = 0.20; 35.0 % for control and 32.3 % for NaHCO3), and 24 h hematocrit (P = 0.36; 34.3 % for control and 32.4% for NaHCO3). There were no advantages to adding NaHCO3 to PMC, possibly the difference in pH between the treatments was too similar to detect an effect.

Addition of sodium bicarbonate to either one or two feedings of colostrum replacer: Effect on uptake and rate of absorption of IgG in neonatal calves.

Previous research from our laboratory involving adding sodium bicarbonate to colostrum replacer (CR) were mixed with data from Morrill et al (2010) indicating a benefit to adding NaHCO3 to CR through increased IgG uptake or a negative linear response to added NaHCO3 especially at the 45 g treatment (Cabral et al., 2011). The primary difference between these two experiments was that Cabral et al. (2011) fed the CR in one large feeding at birth and Morrill et al (2010) split the CR into 2 feedings- 2/3 at birth and 1/3 6 h later. We hypothesized that Cabral et al. (2011) may have saturated the absorptive capacity of the small intestine for IgG. Therefore, we devised the following experiment comparing feeding regimen with NaHCO3.We used a randomized complete block design with a 2×2 factorial arrangement of treatments to test the effects of 1(within 45 min of birth) vs. 2 feedings (2/3 within 45 min of birth and 1/3 6 h later) of CR with or without 30 g NaHCO3. Total amount of CR fed was the same across the treatments. Likewise all NaHCO3 was fed in the first feeding or split between the 2 feedings. We used 40 Holstein calves; blood samples were taken at 0 (within 30 min), 6, 12, 18 and 24 h after birth and analyzed for serum IgG concentration. We calculated AEA, AUC, and rate of absorption. All but 2 calves failed to attain passive transfer (serum IgG > 10 g/L at 24h), 1 on the 1 feeding control and 1 on the 1 feeding NaHCO3. The addition of NaHCO3 alone or the feeding regimen alone did not affect any of the parameters of this experiment. However, rate of absorption was greater between 6 and 12 h for the 1 feeding vs. 2 feedings (P = 0.05; 1.25 g/h vs. 0.99 g/h). However, interactions were observed for 24 h IgG concentration (P= 0.02), AUC (P = 0.02) and a trend for AEA (P = 0.06). Calves fed the 1 feeding of CR with NaHCO3 or 2 feedings of CR had similar 24 h IgG concentrations (16.9 and 16.8 g/L, respectively) and were higher than 1 feeding (15.8 g/L) or 2 feedings with NaHCO3 (15.0 g/L); similarly AUC (309 and 313 g/L × h, respectively) and were higher than 1 feeding (295 g/L × h) or 2 feedings with NaHCO3 (262 g/L × h) and AEA (35.5 % and 32.8 %, respectively) tended to be higher than 1 feeding (32.1 %) or 2 feedings with NaHCO3 (29.4 %). Results indicate that 30 g of NaHCO3 should be added to CR if it is to be fed in one dose. Similar results were observed with no additional NaHCO3 when 2/3 of the CR is fed at birth and 1/3 is fed 6 h later.

Lasalocid and chlortetracycline for growing dairy heifers.

Forty 12 week old Holstein heifers were used to determine the effects of chlortetracycline (CTC), lasalocid (LAS) or the combination (COM using a 2×2 factorial arrangement of treatments in a randomized complete block design. Heifers were fed diets balanced to gain 800 g/d. The experiment was 12 weeks in length. Daily individual intakes, weekly weight and skeletal measurements were taken. Blood was sampled 3 times/week for analysis of haptoglobin and T4. Lasalocid was fed at the rate of 1 mg/kg body weight and CTC was fed at 350 mg/d. The COM treatment included both treatments fed at these rates. However, CTC and the COM treatments were only fed for a 5 d duration weekly. The CTC and COM were fed for 4 weeks on followed by 1 week off, 1 week on, 3 weeks off, 1 week on, and 2 weeks off per the recommendation of the manufacturer of the CTC and LAS. Results indicated that heifers

receiving CTC tended (P= 0.06) to have a greater ADG compared to calves not receiving CTC (1.085 kg/d vs.1.025 kg/d, SE = 0.03). The study is nearing completion.

Effects of increased hutch ventilation on dairy calf performance.

Heat stress can negatively affect the performance of dairy calves. Simple management strategies, such as increased ventilation of calf hutches, may assist with alleviating heat stress in dairy calves. The objective of this study was to determine if raising the back of calf hutches to increase ventilation during summer months had an effect on dairy calf performance. Thirty Holstein heifer calves (BW = 42.2 ± 16.0 kg) were moved to calf hutches with outside pens 2 to 3 d after birth and reared according to the protocols of the Purdue Dairy Research and Education Center. Hutches were bedded with wood shavings. Calves had ad libitum access to calf starter and water and received 2 L of milk replacer twice/d. Calves were blocked in groups of two and randomly assigned to one of two treatments: DOWN, with the back of the hutch on the ground, or UP, with the back of the hutch raised 20 cm. Upon assignment to treatment, calves were measured at 0800 hrs to determine BW, hip height (HH), wither height (WH), heart girth circumference, and rectal body temperature (TEMP). Measurements were repeated at 2, 4, and 6 wks after assignment to treatment. Respiration rate (RESP) and TEMP were determined twice/wk at 1400 hrs. Data were analyzed as repeated records using mixed models. Calves on treatments had similar ($P > 0.10$) ADG, HH gains, and WH gains (0.46 kg/d, 0.19 cm/d and 0.17 cm/d, respectively). Similarly, heart girth circumference and morning TEMP did not differ between treatments. Afternoon air temperatures during the study averaged 25.2°C and ranged from 16.1 to 30.0°C. Respiration rates (65.7 breaths/min) and afternoon TEMP (38.9°C) were similar ($P > 0.10$) between treatments. Raising the back of calf hutches to increase ventilation did not improve calf performance in mild summer temperatures.

Effects of different flooring options in outside pens of hutches on dairy calf growth.

Growth rates of dairy calves may vary due to many different factors, including housing. The objective of this study was to determine if calf growth was affected by different flooring options in the outside pen area of a calf hutch. For this study, 33 hutches were blocked in groups of 3 by location and the outside pen area was randomly assigned to 1 of 3 treatments: soil and lime (CONTROL), solid black rubber mats (SOLID), and black rubber mats with 2.5 cm holes (HOLES). Data were analyzed with Proc Mixed of SAS using repeated measures. Two calves, on treatments SOLID and CONTROL, died for reasons unrelated to treatment and were removed from the study. At 8 wk of age, BW was greater ($P < 0.05$) for HOLES and CONTROL than for SOLID (72.5, 69.2, and 64.0 kg, respectively), and HH and WH were greater for HOLES ($P < 0.05$) than for CONTROL and SOLID. Heart girth circumference and TEMP were similar among treatments ($P > 0.20$). Mat temperatures were similar for SOLID and HOLES (46.5 and 46.0°C, respectively) and were greater ($P < 0.001$) than CONTROL (37.7°C). Calf and bedding cleanliness were similar among treatments, though flooring tended ($P < 0.10$) to be dryer for HOLES at the beginning and dirtier in the middle of the study. Flooring options in the outside pen of calf hutches affected calf BW, HH, and WH at weaning, with rubber mats with holes improving calf growth compared to a lime and soil mixture or solid mats.

Effect of Bedding Material on Performance, Health, and Hide Contamination of Calves Reared in Hutches.

Dairy calf hutches are often bedded with straw (STR), but sand (SND) and wood shavings (SHV) are becoming more common. This study compared 3 different beddings for growth and health of calves and microbial presence on their hides. Hutches were blocked by location and each of 3 hutches in a block was randomly assigned 1 of 3 treatments; SND, STR, or SHV. Twenty-eight heifer calves in the study were assigned sequentially by birth date to the next available hutch. The study was conducted during a moderate summer (June to September, 2008) at the Purdue Dairy Research and Education Center. Calves were observed twice weekly from birth to weaning at approximately 8.5 wk. Weight (BW), hip height (HH), wither height (WH), and heart girth (HG) were measured weekly. Calves were scored for respiratory (RH) and fecal health (FH), and appearance (APP) twice weekly. At 4 and 8 wk of age, hide bacteria swabs were obtained from a 100 sq. cm area on the right mid-abdomen and used to determine total aerobic and coliform populations. Statistical models considered, block and treatment. Additionally, for measures after d 1 of age, covariates of age and birth BW were included. Block affected only WH rate of growth to 4 wk of age and to weaning ($P < 0.05$). Treatment affected weaning HH ($P < 0.05$). Least squares means (LSMEANS) of HH for SND (92.5 cm) and STR (93.8 cm) were greater than for SHV (90.5). However, over the entire period of time, wk ($P < 0.001$) affected all measures of growth, but treatment and its interaction with wk did not. Treatment differences were not detected for RH, FH, APP or total aerobic and coliform counts ($P > 0.05$) at 4 or 8 wk. It appears there are no clear advantages or disadvantages for SND, STR, or SHV as bedding materials with respect to calf growth, general health and hide contamination during moderate summer conditions in the Midwest.

Effects of co-grazing dairy heifers with goats on animal performance, pasture composition, and dry matter yield.

Various pasture management systems, such as co-grazing, may offer alternative methods for rearing dairy heifers. The objective of this study was to determine the effects of co-grazing Holstein heifers with goats on animal performance, pasture composition, and forage DM yield. Twenty-four heifers (age = 165.8 d; BW = 168.0 kg) and 6 goats (BW = 33.7 kg) were allocated to 6 paddocks and used to evaluate 2 grazing strategies (heifers grazed alone (HO) or heifers co-grazed with goats (HG)). Additionally, 6 goats were randomly assigned to 2 paddocks and grazed alone to compare parasitism between grazing strategies. Heifers were weighed biweekly and measured monthly for body condition score, hip and withers heights, and heart girth. Total and pasture DMI were greater for HO than HG heifers ($P < 0.01$); however, ADG and G:F were similar between grazing strategies. Final hip and withers heights were greater for HO heifers ($P < 0.01$). Heifer PUN concentrations tended to be greater for HG heifers at 8 wks ($P < 0.10$), and blood glucose concentrations tended to be less for HG heifers over the entire study ($P < 0.10$). Overall FEC, FAMACHA scores, and PUN concentrations were similar between grazing strategies for goats. Grass and total DM yield tended ($P < 0.10$) to be greater in HO pastures compared to HG pastures after two rotations. Using visual estimation, HO pastures had 3.5 times greater weed presence than HG pastures ($P < 0.05$) at the conclusion of the study. In summary, co-grazing did not affect overall weight gains or feed efficiency of heifers or goats, indicating that replacement heifers can be successfully co-grazed with other livestock species.

Evaluation of dry hay and baleage for transitioning post-weaned, prepubertal dairy heifers to higher forage diets.

Dairy heifers often undergo rapid diet changes as they transition from the post-weaned phase to the growing period. The objective of this study was to determine whether feeding dry or ensiled forages during the transition period improved heifer performance and rumen parameters. Sixty Holstein heifers (141.9 ± 1.2 kg BW) were randomly assigned to 1 of 12 pens for a 4 wk period. Individual pens were assigned to 1 of 2 treatments: dry hay (H) or baleage (B) and were fed diets containing 40% hay or baleage (on a DM basis). Average daily gain (ADG) was greater ($P = 0.04$) for H than for B (1.01 and 0.89 kg/d, respectively), though final BW were similar ($P = 0.26$). Heifers fed H had gain to feed ratios of 0.071 compared to 0.037 kg/kg for B during wk 4 ($P = 0.03$), and DMI were similar between treatments over the study ($P = 0.44$). Hip height, withers height, HGC, and BCS were similar between treatments. Rumen pH was greater for B than for H at wk 2 (6.85 and 6.58, respectively; $P = 0.01$), and rumen ammonia ($P < 0.01$) levels were greater for H at wk 2 with levels of 15.5 and 11.7 mg/dl for H and B, respectively. Cellulose disappearance was similar between treatments ($P = 0.25$). Plasma urea nitrogen was greater for H at both wk 2 and 4 ($P = 0.02$). Blood amylase was similar between treatments, but there was a trend ($P < 0.10$) for blood glucose levels to be greater in H at wk 2. Diets containing dry hay resulted in greater ADG than heifers fed ensiled forage during the transition period.

Effects of feeding hay and baleage on growth and rumen parameters in prepubertal Holstein heifers.

Although ensiled forages are commonly included in diets of growing dairy heifers, little research has been conducted to evaluate feeding baleage as a primary forage source. The objectives of this study were to evaluate the effects of feeding dry hay or baleage to prepubertal dairy heifers on growth, feed efficiency, and rumen parameters. Thirty-six Holstein heifers (age = 189.3 ± 9.3 d; BW = 185.3 ± 1.3 kg) were randomly assigned to 1 of 12 pens and fed a 60:40 forage-to-concentrate diet (DM basis) containing either dry hay (H) or baleage (B) as the only forage source. Data were analyzed as repeated measures using the MIXED procedure of SAS with pen as the experimental unit. Heifers fed H were 6.7 kg heavier ($P < 0.01$) than heifers fed B at the conclusion of the study. Heifers fed H also gained 0.63 kg/d compared to 0.56 kg/d for heifers fed B ($P < 0.05$). Overall, heifers fed H consumed 0.30 kg more DM/d than B ($P < 0.01$), resulting in a tendency ($P < 0.10$) for a 5.4% improvement in gain to feed ratios for H compared to B. Hip and withers heights, HGC, and BCS were similar ($P > 0.10$) between treatments. Plasma urea nitrogen and glucose concentrations were similar between treatments ($P > 0.10$), as was rumen pH ($P > 0.10$). Cellulose disappearance tended to be 9.4% greater for H compared to B ($P < 0.10$); however, total in vitro gas production was similar between treatments. Rumen ammonia concentrations were similar between H and B ($P > 0.10$), though ammonia concentrations declined significantly from 16.3 to 13.2 mg/dL over the entire study ($P < 0.05$). In summary, feeding baleage decreased BW gain, but did not alter skeletal growth or rumen parameters in prepubertal dairy heifers.

Body growth rates and first lactation milk production of pregnant heifers on intensively-grazed pasture (P) to those fed conventional (C) diets.

Pregnant Holstein heifers were assigned to P (n=15) or C (n=15) using breeding dates. Control heifers were fed a TMR including corn and rye silages, grass hay, and monensin-supplemented

grain mix. Pastured heifers were fed one lb/animal/day of ground shelled corn with minerals and monensin. Grazing ran from March 25 to June 30. Pasture consisted primarily of endophyte-infected tall fescue. Pasture-fed heifers were rotated daily to a new paddock of 0.1 to 0.3 ha, based on available dry matter. Biweekly measurements included: body weight (BW), wither height (WH), hip height (HH), body condition score (BCS). Growth measurements were fitted by quadratic regression to generate growth curves for individual animals. First derivatives of individual regression equations were used to estimate average daily growth rates for BW, WH, and HH. Growth rates and projected first lactation 305 day actual milk, fat, and protein production from DHI records were analyzed using analysis of variance. Pastured heifers had a trend for increased ($P = 0.08$) average daily gain (ADG), reduced ($P = 0.001$) BCS, a trend for decreased ($P = 0.06$) HH gain and no differences in WH gain as compared to C heifers. Projected milk and fat yields did not differ while protein yields were increased ($P = 0.04$) by P. While P reduces BCS, it can be used in pregnant heifers without detrimental effects on skeletal development or milk production.

Effects of different yeast additives on health and growth performance of Holstein heifers.

We have completed one project using pre-weaned Holstein heifers to test the effects of different yeast additives as replacements for antibiotics in milk replacer. We examined effects of yeast/MOS, beta-glucans, and coccidiostat on health and growth performance. Results- Type or amount of additive did not improve dry matter intake, growth, or feed efficiency. No differences were noted. Calves fed MOS or MOS combination excreted greater concentrations of E. Coli in their feces ($P < 0.05$), this affect disappeared post weaning when administration of additive had stopped.

Shade type preference and effects on growth in young dairy heifers.

Data were collected from 21 Holstein heifers to evaluate effects of shade type on heat abatement and growth. Heifers were housed in groups of 7 on three paddocks with access to three different type of shade: 1. Natural shade trees, 2. Pro-tel supermax calf hutches, and 3. Metal structure with shade cloth. Heifers were measured weekly for body weight and measures and blood samples were taken to determine packed cell volume and total serum protein (measures of hydration). Observations were also conducted twice weekly to evaluate time spent in and out of shade within each shade type. Results- Data are being analyzed.

B. PROJECT OBJECTIVE 2 (COWS)

Eating Behavior, ruminal fermentation, and milk production in lactating dairy cows fed rations that varied in dry alfalfa hay and alfalfa silage content

Studies were conducted with the objective to evaluate effects of various inclusion levels of dry chopped alfalfa hay and alfalfa silage in lactating dairy cow rations on eating behavior, rumen fermentation, milk yield and components. Eight multiparous Holstein cows (79 ± 11 d in milk initially; 647 ± 36 kg body weight) were randomly assigned to replicated 4 × 4 Latin squares. During each of the 4 periods, cows were fed 1 of 4 diets that were chemically similar but varied in dry chopped alfalfa hay level. Forage dry matter (DM) content of each ration consisted of 50% corn silage and 5, 10, 20, or 40% dry chopped alfalfa hay. The remaining forage DM content was alfalfa silage (45, 40, 30, and 10% respectively). It was determined that sorting did not change with increasing alfalfa hay content and that dry alfalfa hay can be included in the ration up to 23.5% of ration DM with no negative effects on DM intake, milk yield, and rumen fermentation. Small decreases in milk fat and protein content occurred with increasing dry hay inclusion. Despite changes in total mixed ration refusal particle size distribution throughout the d, by 24 h after feeding no significant ration sorting occurred when measured either by selection indices or actual consumption of various particle size fractions (> 19.0, > 8.0, > 1.18 mm, and pan).

Factors affecting milk fat in dairy rations containing DDGS.

Twenty midlactation Holstein cows were used to evaluate the impact of increased corn oil and corn starch in diets containing DDGS on milk fat productionAnimals were assigned to one of five 4 x 4 Latin squares and fed 1 of 4 treatments during each of the four 21-d periods. Treatments were 1) Control diets containing 20% (DM basis) DDGS; this diet contained 20% starch and 5.4 % ether extract 2) Oil, similar to the Control but corn oil was added at 0.97% of the ration DM; this diet contained 20% starch and 6.4 % ether extract 3) Starch, similar to the Control but additional corn was added at 7.8% of the ration DM; this diet contained 26% starch and 5.6 % ether extract. 4) Combination, similar to the Control but additional corn oil and corn were added at 0.97 amd 7.8% of the ration DM; this diet contained 25% starch and 6.5 % ether extract. Milk yield was similar across treatments and averaged 26.6 ± 1.01 Kg. Similarly, milk protein was not affected by treatment. Overall means of milk protein concentration and yield were 3.17 ± 0.05% and 0.83 ± 0.03. There were small differences ($P < 0.01$) in MUN (11.13, 11.63, 11.32 and 10.73 ± 0.38 mg/dL for Control, Oil, Starch and Combination, respectively). Body weight and BCS were not affected by treatment in neither experiment. Milk fat concentration and yield were significantly affected ($P < 0.01$) by treatment. There appeared to be an additive effect of oil and starch inclusion in the diets which resulted in the lowest concentration (2.72 ± 0.15%) and yield (0.71 ± 0.05 Kg/d) of milk fat by cows consuming the Combination ration; cows receiving the Oil and Starch rations had similar intermediate value averaging 3.00 and 3.03 ± 0.15% and 0.77 and 0.78 ± 0.05 kg/d whereas the Control ration resulted in the highest milk fat concentration, 3.35 ± 0.15, and yield, 0.90 ± 0.05 Kg/d. Concomitant with these observations, FCM was significantly affected by treatment ($P < 0.01$).

Specifically, yield of FCM was the lowest when cows received the Combination ration (22.8 ± 1.12 Kg); cows consuming the Oil and Starch rations were intermediate (23.6 and 24.2 ± 1.12 Kg, respectively); and cows receiving the Control ration produced the highest FCM (26.5 ± 1.12 Kg).

Impact of feeding DDGS on physiological Lys levels and milk protein production.

Steady and increase growth of the corn-ethanol industry paired with the increase costs of commodities such as corn and soybeans has resulted in increased use of dried distillers grains and soluble (DDGS) by the dairy industry. Research has shown that levels as high as 30% of the ration DM may be fed without negatively affecting milk production. Limiting amino acids (AA) are defined as those amino acids that are in shortest supply. The NRC (2001) suggests methionine (Met) is most limiting in rations that depend upon soy or animal protein for major rumen undegradable protein (RUP) supply. In rations that are formulated to contain high levels of corn products, the supply of lysine (Lys) is believed to be more limiting. The objective of the following study is to test the impact of feeding increasing amounts of DDGS to lactating dairy cows. A total of three diets were formulated resulting in three experimental treatments. The control diet containing no DDGS was formulated using the CPM-Dairy meeting the needs of ME and MP of a cows consuming 23.4 kg of feed, weighing 680 kg BW, with a BCS of 3.00 BCS, producing 38.5 kg milk, that contains 3.0 % and 3.5% protein and fat respectively. Based on the CPM-Dairy model predicted that LYS and MET supplied 2.28 and 6.86 % of the MP and met 127 and 117% of the requirements of the animals. Two additional treatments were formulated that contained reducing levels of LYS. Reduction of the concentration of lysine in MP was achieved by replacing feeds contained in the grain mix (i.e. corn grain, soybean meal, and blood meal) with dried distillers grains plus solubles (DDGS). The formulations of these diets predicted that the concentration of LYS in the MP was 6.37 and 5.88 or 99 and 91 % of the animals requirements. Dietary treatments (DM basis) were as follows: 1) Control, adequate in LYS, 2) low lysine (LL) 3) medium lysine (ML). Based on milk production and DIM, twenty Holstein cows (approximately 116 + 26.7 DIM) were assigned to treatments in a crossover design. Diet sequences were randomly assigned to cows and experimental periods lasted 21 d. Milk yield was similar and averaged 30.7 kg/d across diets. Treatments did not affect ($P>0.40$) milk fat and lactose composition across diets and averaged 3.74 and 4.67% respectively. Compared to cows fed the control diet, cows fed diets with DDGS diet produced milk with higher ($P<0.01$) protein concentration (3.23 % and 3.21 % versus 3.15 for ML, LL and Control respectively). Protein yield was lowest ($P=0.04$) for cows fed the control diet (0.94 kg/d) compared to cows fed the other diets (0.98 and 1.01 kg/d for ML and LL respectively). The inclusion of DDGS in the diets resulted in a lower concentration of lysine in blood plasma ($P<0.01$) (14.1, 14.0, and 12.3 μg/mL for Control, ML and LL receptively). Results of this study suggest that the inclusion of DDGS did not result in a deficiency of lysine. It is possible that mammary gland was capable of sustaining milk protein synthesis because the extraction efficiency was increased so that LYS was not limiting for either milk or milk protein synthesis.

Evaluation of predicted Lys supply to lactating dairy cows are fed co-products from the dry milling industry are fed.

A meta-analytical procedure was used to evaluate the impact of feeding corn milling co-products from the dry milling industry on the predicted flow of LYS and on the concentration of protein in milk. We also evaluated the impact of these feeds on the predictions of MP and NEL allowable milk. Data from 22 nutrition experiments published after 2001, which included 74 dietary treatments were used. Data were analyzed using SAS and a random coefficient model to account for the random effects of different experiments and the fixed effect of co-products (CBP), Zero= no co-products, Low = low co-products < 10% of the diet DM, and High = high co-products, > 10% of the diet DM. Based on data presented in each study, the diet concentration Metabolizable Protein (MP) and NEL were computed using NRC (2001) equations. Mean DMI and 3.5% FCM averaged 23.9 ± 1.9 and 34.3 ± 4.38 kg/d, respectively. The mean concentration of NEL was estimated to be 1.59 ± 0.03 Mcal/ kg. The inclusion of CBP affected ($P < 0.01$) LYS supplied in the MP, and was observed to be 6.47 (0.052). 6.16 (0.073), and 5.73 (0.046) %, for Zero, Low and High respectively. In comparison the supply of MET was not affected by CBP averaging 1.90 (0.03) % of MP. The error in NEL predictions was not affected ($P = 0.84$) by the inclusion of CBP and averaged 5.39 + 1.56 kg/d. The error in MP predicted milk was affected by the inclusion of CBP and was lower for Zero (2.44 + 1.29 kg/d) compared to Low (4.57 + 1.55 kg/d) and High (4.21 + 1.21 kg/d). Despite difference in predicted Lys flow, no differences were observed in either the concentration or yield of milk protein averaging 3.09 + 0.03% and 1.04 + 0.03 kg/d respectively. These results suggest that although the inclusion of corn milling co-products reduce the flow of Lys, reductions on milk protein yield may not naturally follow.

The effect of dried distillers grains with solubles when replacing corn or soybean meal on rumen microbial growth in vitro as measured using real-time PCR.

The objectives were to evaluate the effect of dried distillers grains with solubles (DDGS) and in vitro fermentation time on the growth of rumen bacteria and protozoa, and to measure the contribution of yeast originating from DDGS to total microbial crude protein (MCP). Treatments were: 1) CONT, control with no DDGS, but with alfalfa hay, corn silage (CS), ground corn (GC) and soybean meal (SBM) included at 25% (DM basis); 2) RC, 20% (DM Basis) DDGS replacing GC; 3) RS, 20% (DM basis) DDGS replacing SBM; 4) RCS, 20% DDGS replacing 10% GC and 10% SBM (DM basis). For each treatment, 0.5 g of substrate was incubated in vitro in 50 mL of inoculum in duplicate. At 0, 4, 16, 32, 48 and 96 h of fermentation DNA was extracted from each treatment and microbial protein was measured by real-time PCR. Microbial markers used are from the 16S rRNA gene, 18S rRNA gene and the II chromosome; for bacteria, protozoa and yeast, respectively. Data were analyzed as a completely randomized design with repeated measures to test the effects of treatments and fermentation time. Treatment did not affect ($P = 0.23$) mean bacterial crude protein (BCP) which was observed to be 30.98 ± 3.19 mg/g of substrate (DM basis) across treatments. However, a treatment by time interaction was observed ($P < 0.05$). Specifically, at 16 h the RCS diet yielded higher ($P < 0.01$) BCP than CONT (58.20

and 26.86 ± 6.79 mg/g of substrate DM for RCS and CONT, respectively). However, at 32 h only the RS yielded higher ($P < 0.05$) BCP than the CONT (70.75 and 45.20 ± 6.79 mg/g of substrate DM for RS and CONT, respectively). In addition, compared to the CONT, BCP of RCS at 32 h tended ($P = 0.09$) to be higher (61.86 and 45.20 ± 6.79 mg/g of substrate DM for RCS and CONT, respectively). At 32 h, the RCS diet yielded higher ($P < 0.01$) protozoal crude protein (PCP) when compared to the CONT (29.76 and 21.17 ± 1.92 mg/g of substrate DM for RCS and CONT, respectively). Treatment did not affect ($P = 0.21$) yeast crude protein (YCP) and averaged 0.04 ± 0.01 mg/g of substrate DM. Overall, results suggest that rumen microbial growth was improved when DDGS replaced SBM and it was maintained when DDGS replaced GC. In addition, yeast contribution to total MCP was minimal.

Relationships among temperature, moisture, bacterial counts, and animal hygiene in compost bedded pack barns

The objective of this study was to assess the relationships among temperature, moisture, bacterial counts, and animal hygiene for composted material collected from compost bedded pack (CBP) barns. Compost samples were collected from 54 CBP barns in Kentucky from October 2010 to February 2011. A composite sample was collected from 9 evenly distributed sampling areas throughout each barn for analysis of nutrient composition and bacterial counts. Compost moisture was measured using an oven at 75°C. Compost temperatures (CT) were measured 10.2 cm below the pack surface. Subjective hygiene scores were collected by the same observer for 50.4 ± 16.1 cows per herd. Producers reported their most recent SCC. The MEANS procedure of SAS® (Cary, NC) was used to calculate mean (± SD) SCC (238,162.2 ± 81,701.5 cells per mL, n=37), hygiene score (2.22 ± 0.46, n=43), moisture (54.9 ± 12.5%, n=51), CT (30.5 ± 11.4°C, n=52), coliform (6.09 ± 0.63 $\log_{10}$ cfu/g, n=54), *Escherichia coli* (5.73 ± 0.68 $\log_{10}$ cfu/g), streptococcal species (7.00 ± 0.68 $\log_{10}$ cfu/g, n=54), staphylococcal species (7.60 ± 0.49 $\log_{10}$ cfu/g, n=53), and bacillus species (7.30 ± 0.56 $\log_{10}$ cfu/g, n=54). Moisture was highly correlated with ambient temperature ($r=-0.73$, $P<0.01$). Moisture was negatively correlated with CT ($r=-0.38$, $P<0.01$) and positively correlated with hygiene score ($r=0.68$, $P<0.01$). Hygiene score and CT were also negatively correlated ($r=-0.42$, $P<0.01$). *Escherichia coli* count was moderately correlated with CT, moisture, SCC, and hygiene score ($r=0.62$, $P<0.01$; $r=-0.41$, $P<0.01$; $r=0.42$, $P<0.01$; and $r=-0.39$, $P<0.02$). No significant correlations between coliform, staphylococcal species, streptococcal species, and bacillus species counts and CT ($P>0.10$) were observed. These results suggest that high CT and low moisture are important for maintaining a dry resting surface for cows and may contribute to pack bacterial counts.

An overview of compost bedded pack management in Kentucky

Compost bedded pack (**CBP**) barn design and pack maintenance procedures vary considerably, making advising and problem-solving challenging. The objectives of this research were to characterize herd performance and management practices employed by CBP managers in Kentucky (45 farms and 54 CBP facilities). Mean (± SD) producer-reported bulk tank SCC and

daily milk yield per cow were 238,162.2 ± 81,702.5 cells per mL (n=37) and 27.3 ± 4.8 kg, respectively (n=46). The TTEST procedure of SAS® (Cary, NC) was used to compare herd performance metrics for the year before and year after transitioning to a CBP for farms using DHIA (n=9). No significant differences (P>0.10) were observed for changes in SCC (325,222.2 ± 197,188.9 to 274,888.9 ± 135,102.2 cells per mL), rolling herd average milk yield (9,476 ± 601.7 kg to 9,363.1 ± 586.4 kg), heat detection rates (21.6 ± 20.7% to 24.3 ± 23.1%), or culling rates (32.2 ± 8.9% to 28.6 ± 5.7%). Kiln-dried sawdust was used by 25 producers (53.2%) with green sawdust used by 15 producers (31.9%) and 7 using a mix of green and kiln-dried sawdust (14.9%). Mean (± SD) time between additions of new bedding to the pack in summer was 15.3 ± 12.7 days and 11.7 ± 10.4 days in winter. With regard to pack stirring, 38 producers (80.8%) used a field cultivator while 6 used a rototiller (12.8%) and 3 alternated between using a cultivator and rototiller (6.4%). Mean (± SD) daily stirring frequency was 1.6 ± 0.5 days in summer and 1.7 ± 0.5 days in winter. The mean pack area was 9.5 ± 3.8 m^2 per cow. Mean (± SD) herd average locomotion and hygiene scores were 1.51 ± 0.30 (n=35) and 2.20 ± 0.28 (n=38), respectively. Most frequently cited benefits of CBP included cow comfort (n=28), cow cleanliness (n=15), and improved health and longevity (n=14). Recommendations to other producers included securing an adequate bedding supply (n=8), stirring twice daily (n=8), and using kiln-dried shavings (n=5). Criteria for adding new bedding included pack moisture (n=30), compost sticking to cows (n=12), and cow cleanliness (n=7).

Potential for estrus detection in dairy cattle using reticular temperature monitors

An experiment was designed to evaluate the utility of reticular (RT) and vaginal (VT) temperatures in predicting the time of ovulation in dairy cows. Lactating Holstein and crossbred (n=30) cows were synchronized using an OVSYNCH protocol preceded by G6G. The first injection of prostaglandin Fα (PGF) was administered 40 to 90 days postpartum. OVSYNCH was modified by omitting the last injection of GnRH. The RT and VT were monitored using SmartBoluses® (TenXsys Inc., Eagle, ID) inserted at least 5 days prior to anticipated estrus. Boluses were placed in the reticulum according to the manufacturer. Boluses were fixed to CIDR devices lacking progesterone (Pfizer Animal Health, NY) and inserted into the vagina using the CIDR speculum. Beginning at 48 h after the PGF injection of OVSYNCH, jugular venous blood samples were collected at 2 h intervals for LH and rectal temperatures were measured. After each sampling, cows were observed for estrus behavior. Beginning 72 h after PGF, ultrasonography was performed every 4 h to determine time of ovulation. Intensive sampling was maintained for 60 h or until ovulation was confirmed. Venous blood samples were collected daily for progesterone as an indicator of ovulation. The time intervals from injection of the OVSYNCH PGF, onset of estrus, LH surge, peak rectal temperature, and first detected increase in RT and VT to ovulation were determined. The mean and standard deviation for each interval was calculated. Only 18 cows ovulated within the sampling time frame and were used in this

analysis. The average intervals in hours (±SD) from injection of the OVSYNCH PGF, onset of estrus, LH surge, peak rectal temperature, first detected increase in RT and VT to ovulation were 93±11, 31±8, 24±6, 46±11, 47±31, 45±27, respectively. The most precise predictor of interval to ovulation was the LH surge. The variation associated with the interval estimates based on RT and VT was high and precludes their usefulness as reliable predictors of the time of ovulation. Supported by the KY Agr Expt Stn and Genex Cooperative, Inc, Shawano, WI.

Evaluation of three dimensional accelerometers to monitor motion changes relative to estrus behavior

Three-dimensional (3D) accelerometers may be used as an estrus detection aid by monitoring changes in cow leg or neck movement. Limited research has been conducted to characterize the changes in movement captured by accelerometers for monitoring estrus behavior. The objective of this study was to utilize a motion index, provided by a commercially available accelerometer, to describe estrus behavior. IceTag™ (IceRobotics Ltd., Edinburgh, Scotland, UK) accelerometers were attached to 15 Holstein or crossbred cows (DIM 40 to 90) at the University of Kentucky Coldstream Dairy Research Farm. Three IceTags were attached to each cow with high grade Velcro (right rear leg, left front leg, and neck). Cows were synchronized using an OVSYNCH protocol preceded by G6G. The first injection of prostaglandin F2α (PGF) was administered 40 to 90 days postpartum. The OVSYNCH protocol was modified by omitting the last injection of GnRH, allowing for the synchronized expression of estrus. Transrectal ultrasonography was utilized to track follicular development. Beginning 72 h after PGF, behavior observations were recorded. Human observers recorded times when cows were mounting (MG, n=116) other cows and being mounted (MD, n=167), for an 8 h period or until estrus ended. Motion index (MI) was used to describe the degree of motion (0= no motion). The MI is defined as total 3D acceleration. A rolling mean (± 2 min) MI was calculated for each estrus event. The GLM procedure of SAS® (Cary, NC) was used to compare MI around estrus behavior events compared to periods where no estrus behavior (NE) was observed. The LSM (± SE) for periods around MD events were significantly higher than LSM for NE (0.847 ± 0.043 ($p< 0.01$), 0.733 ± .038 ($P< .01$), 0.05 ± 0.004 ($p< 0.01$) for front leg, hind leg, and neck, respectively). The LSM for periods around MT events were significantly different than LSM for NE (0.748 ± 0.043 ($p<0.01$), 0.727 ± 0.048 ($p< .01$), 0.055 ± 0.005 ($p< 0.01$), respectively). The MI for periods around MT and MD events appear to be useful for quantifying behavior changes associated with estrus for all three tag locations.

Characterization of management practices utilized by low somatic cell count Kentucky dairy herds

Recent market changes have renewed interest in lowering bulk tank SCC, particularly in the southeastern United States where the highest SCC in the country is observed. The objective of this research was to summarize management practices utilized by Kentucky dairy herds with low

SCC. Herds with an annual mean SCC < 250,000 cells per mL were identified from DHIA and milk cooperative records. A 54 question survey was mailed to 71 producers with 48 producers (67.6%) responding. Herd size ranged from 25 to 750 cows with a mean (± SD) of 144.96 ± 297.39. Mean (± SD) DHIA SCC and producer-reported SCC were 190,333 ± 36,281 (n=27) and 223,475 ± 71,257 (n=40) cells per mL, respectively. The most common management practices incorporated by these producers were post-dipping (100%, n=47), drying teats before attaching milkers (95.8%, n=46), pre-dipping (91.7%, n=44), dry treating all quarters of all cows (85.4%, n=41), incorporating DHIA as a SCC management tool (83.3%, n=40), using individual towels to dry teats (77.1%, n=37), receiving bulk tank SCC (77.1%, n=37), trimming hooves at least annually (75.0%, n=36), performing a milking system evaluation annually (72.9%, n=35), and vaccinating for mastitis pathogens (68.8%, n=33). Of the mastitis vaccines used, J-Vac® (Merial Ltd., Duluth, GA) was most common (40.6%, N=13), followed by J-5 Bacterin™ (Pfizer Inc., New York, NY) (25.0%, n=8), Endovac-Bovi® (Immvac Inc., Columbia, MO) (15.6%, n=5), and Lysigin® (Boehringer Ingelheim, St. Joseph, MO) (15.6%, n=5). When asked to identify the management practice that contributed the most to their low SCC level, the most frequently cited practices were (1) keeping cows and facilities clean (n=31), (2) maintaining dry, clean bedding (n=14), (3) adhering to a consistent milking routine (n=10), (4) forestripping (n=7), and (5) pre- and post-dipping (n=6). Producers with different housing strategies were represented in this study including freestalls, tie-stalls, compost bedded packs, bedded packs, and no housing. Results of this survey may be used to promote best management practices among other producers attempting to lower SCC.

Impact of water intake on dairy cattle reticulorumen temperature

Concerns remain about the effect of water intake on temperatures collected within the reticulorumen. The dramatic drop in reticulorumen temperature (RT) following water intake has been well documented; however, the time required for RT to return to pre-drinking baseline temperature (BT) has not been quantified.The objective of this study was to quantify the relationship between water intake quantity and BT. Four mid-lactation, multiparous, Holstein-Friesian dairy cows were equipped with SmartBolus® transponders (TenXSys, Eagle, ID) set to record RT at two-minute intervals. Cows were housed in a tie-stall barn at the University of Kentucky Coldstream Dairy Research Farm. A TMR ration was provided ad lib at 05:30 and 14:00. One poly water bowl (SMB MFG, Wallenstein, ON) equipped with a range water meter Recordall Badger Meter® (Badger Meter, Milwaukee, WI) was assigned to each tie stall to assess water intake. Drinking behavior was monitored by two observers for 48 consecutive hours. The termination of a drinking bout was established when 30 minutes elapsed without another drink. Quantities consumed within each drinking bout were used for analysis. Mean (±SD) volume of water consumed per drinking event was 0.27 ± 0.31 L. Mean (±SD) temperature drop (TD) across all drinking events was 2.29 ± 1.82 °C. Mean (±SD) RT at the beginning of the drinking event was 39.76 ± 0.49 °C (N =84), while mean water temperature (WT) fifteen minutes before the drinking event was 3.63 ±3.14 °C. Mean (±SD) BT, identified in 50 drinking events (59.5% of total drinking bouts), was 57.75± 38.70 minutes. The BT was moderately correlated with pre-drinking RT ($r=0.57$, $P<0.01$), TD ($r=0.49$, $P<0.01$), and WT ($r=-0.28$, $P<0.05$).The TD was moderately correlated with the pre-drinking RT ($r=0.57$, $P<0.01$), the

amount of water consumed (r=0.53, P<0.01), and BT (r=0.49, P<0.01). Regression was performed with the GLM procedure of SAS® (SAS, Cary, NC) to assess factors influencing BT (R^2=0.36). The quantity of water consumed (P=0.03), and the RT prior to a drinking bout affected BT, while WT did not (P=0.92).

Extension programming in Kentucky to address somatic cell count challenges and opportunities

Recent market changes have renewed interest in lowering bulk tank somatic cell counts (**SCC**), particularly in the southeastern US states where the highest SCC in the country are observed. Extension programming efforts focused on SCC reduction increased around the country in 2010 and 2011. In Kentucky, we have implemented a multi-faceted approach to extension programming for SCC reduction. The University of Kentucky Dairy Extension team has worked closely with the Kentucky Dairy Development Council in a farm-based program entitled M.I.L.K. Counts. The intent of the program is to provide direct, on-farm technical assistance to producers struggling with SCC through evaluation of DHIA records, milking procedures, management protocols, animal hygiene and housing, and dry cow treatment and handling. The M.I.L.K. Counts program incorporates a team based problem solving approach with emphasis on the economic impact of resulting recommendations. Microbiological culturing is performed by the University of Kentucky Veterinary Diagnostic Livestock Laboratory. Approximately twenty-five producers have participated in the program with SCC reductions as high as 400,000 cells/mL. YouTube videos were developed (http://www.youtube.com/user/UKAgriculture) to demonstrate recommended milking procedures and to provide virtual tours of farms that consistently maintain low SCC. A visual analytics dashboard (http://tinyurl.com/UKMilkBonus) was created to illustrate the potential for increased income through SCC reductions. Kentucky herds with annual mean SCC <250,000 were surveyed to summarize management practices employed by farms successful at maintaining low SCC. When asked to identify the management practice that contributed the most to their low SCC level, the most frequently cited practices were (1) keeping cows and facilities clean (N=31), (2) maintaining dry, clean bedding (N=14), (3) adhering to a consistent milking routine (N=10), (4) forestripping (N=7), and (5) pre and post dipping (N=6). Lastly, a series of SCC reduction workshops were conducted across the state working with county extension agents and milk cooperative field people.

Ruminal fermentation and nutrient digestion by dairy cows fed different concentrations of forage and dried distillers grains with solubles.

The study objective was to investigate the effects of concentrations of forages and dried distillers grains with solubles (DG) on ruminal fermentation and nutrient digestion in lactating dairy cows. Four Holstein cows with ruminal fistula were assigned to a 4 × 4 Latin square in a 2 × 2 factorial arrangement of treatments. Diets were formulated containing low forage (LF; 41% of diet DM) or high forage (HF; 60% of diet DM) and DG at 0 or 18% of diet DM. Ground corn and soybean feeds were partially replaced by DG from 0% DG diets to formulate 18% DG diets. Average

DMI was not affected by diets (23.8 kg/d). Rumen evacuation at 4 h post-feeding showed that rumen digesta DM were greater for cows fed HF regardless of the addition of DG. There was a tendency for digesta NDF (7.00 vs. 7.49 kg) to be less for cows fed LF compared with HF, whereas digesta starch (0.53 vs. 0.33 kg) were greater for cows fed LF compared to HF. Lower ruminal pH (6.10 vs. 6.34) was observed in cows fed LF whereas there was no DG effect on ruminal pH. Cows fed LF had greater total VFA concentration compared to cows fed HF (122 vs. 116 mM). Acetate concentrations were lesser for LF (57.5 vs 62.6 mol/100 mol) and 18% DG (61.3 vs 58.7 mol/100 mol) diets whereas propionate concentration were greater for LF (26.0 vs 20.1 mol/100 mol) and 18% DG (21.9 vs 24.2 mol/100 mol) diets. Greater acetate:propionate ratio was observed in HF and 0% DG diets. Total tract digestibility for DM, NDF, CP, and starch was not affected by diets. Results suggest that forage and DG concentration in diets affect ruminal degradability of nutrients.

In situ ruminal degradability of diets, dried distillers grains with solubles and soybean meal under different rumen conditions.

The objective of this study was to investigate the in situ degradability of diets, distillers grains with solubles (DG) and soybean meal (SBM) under different ruminal conditions. Four Holstein cows with ruminal fistulae were assigned to a 4×4 Latin square in a 2×2 factorial arrangement of treatments. Diets contained low forage (LF; 41% of diet DM) or high forage (HF; 60% of diet DM) and DG at 0 or 18% of diet DM. Forage consisted of 80% corn silage and 20% alfalfa hay (DM basis). Ground corn and soybean feeds were partially replaced by DG from 0% DG diets to formulate 18% DG diets. Dacron bags containing DG, SBM, and dietary TMR were incubated in duplicate in the rumens of the cannulated cows at 0, 2, 4, 8, 12, 24, 48, and 72 h on d 15 each period. Each TMR was incubated only in cows assigned to the corresponding diet. Rumen passage rate (Kp) was greater for HF (6.2 vs 6.6%/h) and 0 DG (6.5 vs 6.3%/h) diets. Effective degradability (ED) of DM for TMR was lower for 18% DG diets (64.8 vs 62.7%). Similarly, ED of DM for DG (55.8 vs 55.0%) and SBM (72.0 vs 70.1%) were lower in 18% DG diets. For TMR, ED of NDF was greater in HF (28.0 vs 34.5%) and 18% DG diets (29.9 vs 32.6%) whereas ED of NDF for DG was greater in HF diets (37.1 vs 40.4%). ED of CP for TMR was lower in HF (54.7 vs 53.3%) and 18% DG diets (54.9 vs 53.0%). Similarly, ED of CP for DG was lower for HF (50.6 vs 48.6%) and 18% DG diets (50.1 vs 49.0%). For SBM, CP was degraded to a lower extent for the 18% DG diets (62.7 vs 60.4%). Results suggest that forage and DG concentration in diets affect ruminal degradability of nutrients.

Feeding Whole Safflower to Lactating Cows

A lactation trial was conducted to determine the effects of supplementing whole safflower seeds (SS) on ruminal fermentation, lactational performance, and milk fatty acid (FA) profiles. Nine multiparous Holstein cows (days in milk = 110 ± 20) were used in a replicated 3 × 3 Latin square design. Each period lasted 21 d, with 14 d of adaptation and 7 d of data collection. Within square, cows were randomly assigned to a sequence of 3 dietary treatments as follows:

cottonseed total mixed ration (TMR; CST), conventional SS (variety S-208) TMR (CSST), and NutraSaff SS (Safflower Technologies International, Sidney, MT) TMR (NSST). Diets contained approximately 63% forage (36% alfalfa hay, 4% grass hay, and 23% corn silage) and 37% concentrate supplemented with 2% cottonseed to the CST and 3% conventional or NutraSaff SS to the CSST or the NSST, respectively. Intake of dry matter (DM) averaged 21.8 kg/d and did not differ across diets, but feeding the NSST decreased intake of neutral detergent fiber (NDF) due to lower dietary concentration of NDF in the NSST. Digestibilities of DM and nutrients were similar among treatments. No differences in yields of milk or milk components were observed in response to supplementing SS. Dietary treatments did not affect ruminal pH, total or molar proportions of ruminal volatile FA, and ammonia-N. However, cows fed SS had a higher molar proportion of isobutyrate than those fed the CST diet. Ruminal C16:0 FA concentration increased with the CST, whereas C18:1 cis-9 and C18:2 n-6 tended to increase with SS supplementation, indicating that conventional and NutraSaff SS were partially protected from microbial biohydrogenation. Supplementing SS decreased milk C16:0 concentration, whereas it increased C18:1 cis-9 and C18:1 trans-9. Milk FA C18:1 trans-11 and cis-9, trans-11 conjugated linoleic acid increased and tended to increase with feeding the NSST, respectively, but not the CSST diet

Antimicrobial properties of Different Condensed Tannins

Commercially available quebracho (QT), chestnut (CNT), and mimosa tannins (MT) were used as sources of tannin extracts (TE) to assess growth inhibition of Escherichia coli O157:H7 (EC), Staphylococcus aureus (SA), Salmonella typhimurium (ST), and Listeria monocytogenes (LM) in pure culture. The in vitro experiment was performed in a 3 (source of TE) x 4 (pathogenic bacteria) x 2 (dilution rate) factorial design (n=3). In a second experiment, growth inhibition by TE on 2 strains of rumen acidosis causing bacteria (RACB; Selenomonas ruminantium (SR) and Streptoccus bovis (SB)) was also determined. The CNT elicited an inhibitory effect across all pathogenic bacteria (EC-ST>LM>SA, $P<0.05$). Mimosa tannins had less inhibitory effects compared with CNT, while QT did not affect bacterial growth. At 1:50 dilution, only the CNT inhibited bacterial growth (EC:ST>LM), but the overall response was lower than that in 1:5 dilution. In exp 2, overall growth patterns of RACB differed in response to TE, ($P<0.05$ for RACB x TE interactions). Adding TE decreased growth of SR starting at 2 h, and CNT was most effective to decrease growth of SR at 12 and 24 h followed by MT and QT ($P<0.05$). At 24 h, the CNT decreased growth of SR at 48%. Growth of SB was inhibited by adding TE beginning a t 4 h. At 12 and 24 h, the CNT elicited the least growth of SB followed by the MT and the QT ($P<05$). The CNT decreased growth of SB 73% at24 h.

Two experiments were conducted to determine the effectiveness of co-ensiling wet distiller's grains with solubles (WDGS).

In the first experiment, WDGS was co-ensiled with corn silage by mixing at a ratio of 66:34 corn silage to WDGS in a TMR mixer and then ensiling in an AgBag. In the second experiment,

WDGS was co-ensiled with wilted grass silage at a ratio of 37:63 hay crop silage to WDGS and mixed and ensiled. In each case, the stored mixture was compared to diets in which the individual feed ingredients were combined at feeding. For each trial, 16 cows were utilized and fed both diets in a 3-period switchback design, using periods of 21 days. Unlike the hay crop silage stored with WDGS, the haycrop silage stored alone did show some signs of mold. Milk production, milk composition, and feed intake did not differ for cows fed WDGS that were mixed in the diet at the time of feeding or when WDGS was mixed with the corn silage at harvest. When haycrop forage was direct cut, ensiled and mixed with WDGS at feeding, the cows ate less feed and produced significantly less milk than when the same silage was co-ensiled with WDGS.

Rubber flooring impact on productivity and herdlife of dairy cows.

Use of rubber flooring in dairies has become popular because of perceived cow comfort. The overall objective of this longitudinal study was to evaluate production, reproduction, and retention of first and second lactations of cows assigned to either rubber (RUB) or concrete (CON) flooring at the feed alley. Feeding system included headlocks; and cows were fed once daily, with feed pushed up 5 times daily. Grooved concrete cow alleys provided access to 2 rows of free stalls in each pen. Cows entered the experiment at d -60 prior to first (n = 13 for CON and n = 17 for RUB) lactation and were observed over 2 lactations. Between lactations, cows remained in a straw bedded-pack dry-cow pen. Production and health data were recorded throughout both lactations. Herdlife from first or second calving through death or culling was recorded for each cow. Milk, fat, and protein; somatic cell scores (SCS); and numbers of days open and inseminations were analyzed as a randomized design. Explanatory variables in models included treatment, age and year-season of calving, and number of days open. Days from calving to exiting the herd were analyzed separately by parity. RUB increased mature equivalent (ME) fat (488 vs 432 kg), ME protein (364 vs 326 kg), and protein % (2.99 vs 2.81 %) and persistency of the milk lactation curve (114 vs 106 %) ($P < 0.04$) and tended to increase fat % (4.02 vs 3.70 %) ($P < 0.10$) during first parity. However, during second parity, CON increased ME fat (524 vs 432 kg) ($P < 0.04$) and tended to increase fat % (3.95 vs 3.49 %) ($P < .08$). Treatment by parity interactions for yields and component percentages were confirmed in repeated records analyses. Treatment did not affect SCS, days open, number of breedings, or days of herdlife after first calving or second calving ($P > 0.10$). These data indicate that flooring can influence production and herdlife. Rubber flooring to enhance cow comfort, which was not directly measured in this study, may not be justified solely in terms of yields and herdlife.

Rubber flooring impact on health of dairy cows.

Use of rubber flooring in dairies has become popular because of perceived cow comfort. The overall objective of this longitudinal study was to evaluate locomotion, health, production, and immunity over the first 180d of each of the 1st and 2nd lactations of cows assigned to free-stall housing with either rubber (RUB) or concrete (CON) at the feed-face of their housing. Cows

entered the experiment at d -60 prior to 1st (n = 30) lactation and were observed over 2 lactations. Between lactations cows remained in a straw bedded-pack dry-cow pen. Locomotion scores and blood samples were obtained at approximately -60, -30, 0, +7 and weekly through d +189 relative to calving throughout two lactations. Data were analyzed as a completely randomized design with repeated measures or Chi Square when necessary. Cortisol responses were variable with only an effect of d ($P = 0.05$). White blood cell counts increased for CON cows compared with RUB cows after d 63 through 182. Those counts returned to similar counts of RUB cows over the dry period, but quickly became greater than those of CON cows after parturition (treatment by d interaction, $P < 0.01$). Neutrophil counts only tended to be affected by d ($P = 0.10$) and a weak trend ($P = 0.13$) for a treatment by d interaction was detected. Lymphocyte counts followed the pattern of white blood cell counts, but only had a trend ($P = 0.08$) for a treatment by d effect. Monocytes counts were not affected by treatment or time ($P > 0.10$). Haptoglobin (treatment by d interaction, $P = 0.15$) and ceruloplasmin (week effect, $P = 0.08$) were not affected by treatment. Hoof pathology differed by flooring treatment for number of hoof care treatments required (RUB = 2.1 and CON = 1.4; $P = 0.03$). Lame and sound classifications did not differ between treatments ($P = 0.13$). These data show that flooring not only affects cow locomotion, but alters immune cell counts, which may indicate an underlying chronic inflammation.

Effects of heat stress on milk yield and components in Holstein and Jersey Cows.

Data were collected to evaluate heat stress in Jersey and Holstein cows, managed at the same facility. Ten years' worth of milk yield, component, and somatic cell count information was obtained from Dairy Herd Improvement Association (Raleigh, NC) for the Bearden Dairy Research Center at Mississippi State University. Data was analyzed using Proc Mixed procedure of SAS where test day MY and components, fat corrected milk, and somatic cell count were dependant variables; breed, temperature humidity index (THI), and breed X THI were fixed effects. Days in milk (DIM) were used as a covariate. Results- Milk yield in Holstein cows decreased significantly as THI increased, but milk yield in Jersey cows increased from THI from 70 to 80 and only decreased when THI was above 90. Somatic cell counts also decreased with increasing THI. Much of this data are contradictory to current literature. Cows were subjected to heat abatement (fans and misters) in the freestall barns and the effects of abatement practices may have caused these conflicting results.

C. PROJECT OBJECTIVE 3 (WHOLE FARM)

Using whole farm assessment tools to identify strategies for change to increase dairy farm profitability.

The objectives for this project were to use the Profitability Assessment Dairy Tool (PA Dairy Tool) and the Income Over Feed Cost (IOFC) Tool to 1) identify bottlenecks that limited dairy farm profitability on Pennsylvania dairy farms and 2) to show dairy producers how to make improvements to both overall profitability and IOFC. The PA Dairy Tool calculates key financial ratios, capital efficiency, operational efficiency as well as economic losses in five areas of dairy production management that directly impact profitability: milk yield (MY) and components, reproduction, milk quality and udder health, culling, and replacements. Farms were invited to participate in the project by farm advisors and thirty-eight farms completed both tools in year one. The PA Dairy Tool data utilized year end numbers for 2009. Herd size averaged 184 with a range 31 to 1,582 cows; average milk production was 29 kgs per cow per day (15-41); return on assets averaged -0.7% with a range of -10.2 to 8.7%. The PA Dairy Tool showed the greatest economic losses were due to milk yield ($296 per cow per year) but the majority of farms had economic losses with replacements (age at first calving; 31 of 38 farms), udder health (somatic cell linear score >4.0; 29 of 38 farms), and reproduction (pregnancy rate; 25 of 38 farms). From January through October 2010, IOFC ranged from $3.08 to $10.61 per lactating cow per day. Quarterly reports are sent to participants throughout the project that include summarization of data and educational materials. In year two of the project, monthly IOFC will be continuously collected and year end numbers will be collected for the PA Dairy Tool. Follow up work will be completed on farms that have economic losses in production areas that will enable the producer to focus on specific management improvements to decrease these economic losses. Effective use of evaluation assessments like the PA Dairy Tool and IOFC Tool are effective strategies in helping producers to target the most economically beneficial areas for changes to improve their bottom line.

Identifying efficient dairy heifers operations in Pennsylvania using data envelopment analysis

The cost of raising dairy heifers is an important aspect to the profitability of dairy farms. In addition way those heifers are raised and rates of gain will have impacts on production and age at calving all of which impact the profitability of the farm. This study will focus on determining the actual costs of raising heifers as well as the outcome of those animals in first lactation. We will determine costs on 40-50 dairy farms of various sizes in the major dairy areas of the state, determine growth of the heifers at various stages, and age at calving and first lactation milk production. The final analysis will include determining which heifer operations are most efficient at raising heifers by way of a data envelopment analysis technique.

Dietary saturated fatty acid source and parity influence lactational performance of early lactation Holstein dairy cows.

Dietary coconut oil (CO), a source of predominantly saturated medium-chain fatty acids (FA), reduces enteric methane emissions, but also reduces DMI and milk yield. To better understand the effects of and possible mechanisms associated with CO on lactational performance early

lactation Holstein cows were fed two sources of saturated FA, differing in predominant chain length. Dietary treatments were: 1) no added fat (CTRL); 2) 2.7% of dietary DM as saturated long-chain FA (Energy Booster 100®; EB); 3) 2.7% CO; or, 4) a 2.7% mixture of equal parts EB and CO (intermediate = INT). Primiparous (PP; n = 31) and multiparous (MP; n = 36) Holstein cows 10 to 14 days in milk were fed one of the four dietary treatments for 16 wk in a continuous randomized complete block design. The basal diet (CTRL), containing corn and alfalfa silages (53% of DM), dry ground corn, soybean meal, plus mineral and vitamin supplement; it was formulated to contain 26.5% NDF (83% of NDF from forages), 17.6% crude protein, 29.6% starch, and 3.6% fat. Milk yield and DMI were recorded daily, and venous blood was collected weekly. Data were analyzed by least-squares ANOVA with main effects of dietary treatment, parity, time (repeated measures), and relevant interactions. Results reported differed at $P < 0.05$. Overall, cows fed CTRL had greatest DMI. Dietary fat source with greater chain length (Energy Booster 100®) increased DMI linearly for multiparous cows (CO: 22.7; INT: 24.7; EB: 27.0 kg/cow per d), but in a quadratic fashion for primiparous cows (18.5; 21.0; 20.3 kg/cow per d). Similar responses and interactions of treatment by parity were observed for yields of solids-corrected milk and milk components. The CO treatment reduced milk fat (3.1%) and lactose (4.73%) concentrations compared with EB (3.8% and 4.92%), pooled across time and parity. Plasma glucose concentrations did not differ among treatments across the 16-wk experiment. However, fat source interacted with parity; INT resulted in the lowest glucose concentrations for primiparous cows, but greatest for multiparous cows. During wk 1 through 4 of the experiment, multiparous cows had lower plasma glucose than primiparous cows (52 vs. 58 mg/dL), which coincided with greater plasma beta-hydroxybutyrate concentrations (7.0 vs. 4.8 mg/dL) and non-esterified fatty acids concentrations (710 vs. 380 μeq/L) in multiparous cows. Body condition loss through wk 4 of lactation was greater for cows fed CO and CTRL than for those fed INT and EB. Overall, dietary CO reduced DMI compared with EB leading to a greater body FA mobilization in early lactation. The interaction of parity with dietary treatments for many dependent variables was particularly striking in this study. Coconut oil, although resulting in significant reductions in enteric methane emissions of lactation dairy cows in our previous studies, does not appear to be a likely commercial candidate for dietary use because of quite marked reductions in feed intake, milk yield and milk fat concentration. Major collaborator in this work was M. Hollmann, graduate research assistant, Michigan State University.

Whole herd enteric methane emission estimates in three contrasting dairy feeding systems.

Effects of contrasting dairy feeding systems on diurnal patterns of enteric methane emissions per cow, methane footprint per unit of milk, and frequency of milking in a herd of lactating Holstein cows (n = 61) managed with an automatic milking system (AMS) were quantified. Feeding systems were: 1) pasture grazing (GRASS); 2) a totally mixed ration (TMR); and, 3) pasture grazing plus partial TMR (pTMR) lasting 17, 34, and 84 days, respectively. Voluntary milking with one single-stall AMS was applied at variable rates of about 4 to 2 milkings/cow per day as influenced by days in milk and milk yield. Cows received in addition to the basal diet within the feeding system, 1 kg of an energy-protein concentrate per 4 kg of milk yield. Concentrate was fed in the head-box feeder of the AMS unit. Mass flux of eructed and expired methane was measured (infrared detection) employing tracer gas release of known concentration and flow rate into the head-box feeder at the time of milking. The mass flux of methane during milkings of individual cows (n = 12,584) was estimated in the AMS feeder with the Greenfeed® system (C-Lock Technology, Inc., Rapid City, SD). Repeated measures analysis of hourly methane fluxes,

ANOVA and Pearson correlation of calculated daily methane fluxes and milking variables were conducted; significance was declared at P = 0.05. Hourly methane fluxes were affected by feeding system (feeding system by hour interaction; P < 0.05), likely influenced by differences in daily feed intake patterns of cows in each of the feeding systems. Pasture grazing resulted in greater hourly methane fluxes during night-time hours (2100 to 0500 h); whereas, hourly methane fluxes in the pTMR system, and TMR system increased immediately after the TMR feeding at 0500 h. Total daily methane fluxes per cow did not differ among the feeding systems (average = 389 ± 15 g/cow per day), but cow in GRASS, pTMR and TMR differed in daily milking frequency (2.6, 2.9 and 3.0; SE = 0.1 milking per cow) and milk yield (22, 25 and 29 kg/cow per d; SE = 1.2). Differences in milk yield accounted for the dilution of the methane footprint per unit of milk produced in the TMR system compared with the GRASS system (15 vs. 19 gCH4/kg milk; SE = 1) and the intermediate footprint value for pTMR (17 ± 1 gCH4/kg milk). No correlations between daily methane fluxes and milk yield were detected for the three feeding systems. However, significant negative correlations between milk yield and methane emissions per unit of milk produced in the GRASS (r = -0.67), pTMR (r = -0.72) and TMR (r = -0.79) systems highlight the importance of a high milk production as a common strategy to dilute methane emissions across all dairy systems. Research collaborators were S. Utsumi (lead, assistant professor, Michigan State University), and S. Zimmerman and P. Zimmerman, C-Lock Technology, Inc., Rapid City, South Dakota.

An economic decision-making support system for selection of reproductive management programs on dairy farms.

Because the reproductive performance of lactating dairy cows influences the profitability of dairy operations, predicting the future reproductive and economic performance of dairy herds through decision support systems would be valuable to dairy producers and consultants. In this study, we present a highly adaptable tool created based on a mathematical model combining Markov chain simulation with partial budgeting to obtain the net present value (NPV; $/cow/yr) of different reproductive management programs. The growing complexity of reproductive programs used by dairy farms demands that new decision support systems precisely reflect the events that occur on the farm. Therefore, the model requires productive, reproductive, and economic input data used for simulation of farm conditions to account for all factors related to reproductive management that increase costs and generate revenue. The economic performance of three different reproductive programs can be simultaneously compared with the current model. A program utilizing 100% visual estrous detection (ED) for AI is used as baseline for comparison to two other programs that may include 100% timed AI (TAI) as well as any combination of TAI and ED. A case study is presented in which the model was used to compare three different reproductive management strategies (100% ED baseline vs. two 100% TAI options) using data from a commercial farm in Wisconsin. Sensitivity analysis was then used to assess the impact of varying specific reproductive parameters on the NPV. Under the simulated conditions of the case study, the model indicated that: the two 100% TAI programs were superior to the 100% ED program and among the 100% TAI programs the one with higher conception rate (CR) for resynchronized AI services was economically superior in spite of higher costs and having a longer interbreeding interval. A 4% increase for resynchronized AI was sufficient for the inferior 100% TAI to outperform the superior program. Adding ED to the 100% TAI programs was only beneficial for the program with lower CR. The improvement in service rate required for the 100% ED program to have the same NPV as the superior 100% TAI program

was 12%. The decision support system developed in this study is a valuable tool that may be used to assist dairy producers and industry consultants in selecting the farm-specific best reproductive management strategy.

Decision tree analysis of treatment strategies for mild and moderate cases of clinical mastitis occurring in early lactation.

The objective of this study was to develop a decision tree to evaluate the economic impact of different durations of intramammary treatment for the first case of mild or moderate clinical mastitis (CM) occurring in early lactation with various scenarios of pathogen distributions and variable use of on-farm culture. The first decision node in the tree evaluated use of on-farm culture (OFC) (two programs using OFC and one not using OFC) and the second decision evaluated treatment strategies (no intramammary antimicrobials or antimicrobials administered for 2, 5 or 8d). The tree included probabilities for realistic distributions of etiologies, bacteriological cure and recurrence. The economic consequences of mastitis included costs of diagnosis and initial treatment, additional treatments, labor, discarded milk, milk production losses due to clinical and subclinical mastitis, culling and transmission of infection to other cows (only for CM caused by S. aureus). Pathogen specific estimates for bacteriological cure and milk losses were used. The economically optimal path for several scenarios was determined by comparison of expected monetary values. For most scenarios, the optimal economic strategy was to treat CM caused by Gram-positive pathogens for 2 days and to avoid antimicrobials for CM cases caused by Gram-negative pathogens or when no pathogen was recovered. Use of extended intramammary antimicrobial therapy resulted in the least expected monetary values.

A daily herd Markov-chain model to study the reproductive and economic impact of reproductive programs combining timed artificial insemination and estrous detection

The objective of this study was to compare the economic and reproductive performance of programs combining timed AI (TAI) and different levels of AI after estrous detection (ED) using a daily Markov-chain model. A dairy herd was modeled with every cow following daily probabilistic events of aging, culling, mortality, pregnancy, pregnancy loss, and calving. All non-pregnant cows had a probability of pregnancy between the end of the VWP and a DIM cutoff for AI. After the cutoff, cows were labeled as “do-not-breed” and culled when milk production was below a minimum milk threshold. An algorithm was iterated until the proportion of cows in each state remained unchanged (steady state). A similar model was created to represent a heifer replacement herd to simulate and adjust the supply and demand of replacements. The net value (NV) of a program was the sum of: milk income over feed cost (IOFC), culling and mortality cost, income from newborns, and reproductive costs. The model was used to compare the NV of 19 programs. One program used 100% TAI (42% CR 1st TAI and 30% for 2nd and later services), whereas the other programs combined TAI with ED. The proportion of cows receiving AI after ED for the combined programs ranged from 30 to 80% with levels of CR of 25, 30, and 35%. As the proportion of cows AI after ED increased, the CR of cows receiving TAI decreased. Overall, the combined programs with CR of 35% for cows AI after ED had the greatest NV and reproductive performance at all levels of ED. The program using 100% TAI had greater NV and better reproductive performance than all programs with 25% CR after ED inseminations while it had very similar performance than combined programs with up to 60% of cows AI after ED and 30% CR. The factor with the greatest relative contribution to the differences between programs was IOFC followed by culling and reproductive costs. Adjusting the DIM cutoff for AI to match

the supply and demand of heifer replacements improved the NV of all programs except for those with 25% CR after ED which had either no change or a decrease in NV. In summary, the economic value of reproductive management programs combining TAI and ED depended on the proportion of cows AI after ED and the resulting CR. The impact of adjusting heifer supply and demand on the NV of programs depended on the heifer balance with the original DIM cutoff for AI.

Revenue risk management, risk aversion and the use of livestock gross margin for dairy cattle insurance

The Livestock Gross Margin Insurance for Dairy Cattle is a federally reinsured insurance program that enables U.S. dairy producers to establish minimum levels of milk income net of feed cost. Given the structure of this program there are an infinite number of possible contract designs based on the choice of deductible level and proportion of production insured. Adding to this complexity, producers vary in their risk preferences, which affect the incentive to insure their margin. It is unclear as to how producers may adopt this program for revenue risk management. This paper investigates the interplay between producer risk preferences, contract design and the subsidization of premium in determining program coverage. We undertook this analysis within an expected utility framework. Optimal contracts under different rates of constant relative rate of risk aversion and subsidies were analyzed using a nonlinear optimization model. We found that total optimal coverage increased significantly with the level of risk of aversion at lower deductibles but as deductible level increased, the level of risk aversion had a lesser impact on total optimal coverages. As expected, at the same deductible and risk aversion levels, inclusion of a premium subsidy increased the total optimal coverage.

Analyzing the sources of technical efficiency among heterogeneous dairy farms: A quantile regression approach.

An unbalanced panel data including 1,151 farm observations from 2004 to 2008 was used to analyze the determinants of technical efficiency (TE) for dairy farms in the State of Wisconsin. To account for farm heterogeneity a two-step framework was implemented using a stochastic production frontier and a quantile regression analysis. The results show that the determinants of TE affect in very specific ways farmers with different levels of TE. This outcome is of significant importance from an empirical point of view. Farmers could use this knowledge to find alternatives to improve their specific level of performance. Additionally, Policy makers could use this information to improve the effectiveness of their policies by targeting specific agricultural services and aid to group of farmers with similar levels of TE.

Linear programming for dairy herd simulation and optimization: An integrated approach for decision-making.

The use of linear programming (LP) in farming systems is not a new concept. Linear programming has been used extensively to suggest the impact of alternative management practices at the whole farm level. Although these applications included livestock practices, there have not been many studies that formally and systematically investigated dairy herd systems. Linear programming can be a powerful tool to simulate and optimize the dairy herd system inside a Markov-chain structure. On the other hand, the concept of dynamic programming (DP) for a dairy herd has long been recognized and used to find optimal policies for dairy herd

management. Various options have been analyzed to find optimal replacement policies, reproductive parameters, and feeding strategies in dairy herds by using value or policy iteration methods. However, even though the formulation has been available since the 1980s, the solution of DP using LP has not been widely explored probably because the computer and software systems did not support the solution of real and practical problems. The formulation of DP as an LP problem for real, but large problems is now feasible and has substantial advantages over other methods because it allows the inclusion of the interaction of herd mates, solving for sub-optimal conditions, controlling efficiently for the time steps of the analysis, and uses standard LP algorithms for solution. In the present chapter we discuss the application of LP in dairy herd management to solve DP problems and to propose stochastic simulation and optimization in a Markov-chain structure for decision-making in modern dairy herd management.

Impact of feeding strategies on milk production and income over feed cost: a case study of organic, grazing and conventional Wisconsin dairy farms.

A survey was developed to understand feeding practices on Wisconsin dairy farms and their consequences on milk production and milk income over feed cost (IOFC). Farms were randomly selected across 3 management systems: conventional (CON), grazing (GRA) and organic (ORG). Preliminary results from 2 CON, 3 GRA and 3 ORG are presented. No statistical analysis is reported because of these small numbers of farms. Grains were used in similar amounts across the year 2010 on GRA and ORG, whereas CON used less than half grain in summer than in winter. Grains were partially replaced in CON by a protein mix that was used more than double in summer than in winter. Hay was the main component in the winter for all the farm systems, which was partially replaced by grazing during summer. Corn silage, haylage, and baleage were used in similar amounts throughout the year by CON and ORG, whereas GRA used an additional 3.9 kg DM/cow/d in summer. In total, DMI in winter (kg/cow/d) was higher for CON and GRA (24.6 and 23.8, respectively) than for ORG (15.0), which led to differences in milk production (kg/cow/d) and cost of feed, ($/cow/d) for CON (27.3 and 2.6), GRA (20.0 and 1.5), and ORG (10.4 and 1.5). Milk price for ORG ($60/100 kg milk) was about twice as much as CON and GRA. Calculated milk IOFC ($/cow/d) was higher for CON (6.8) in winter and for ORG (7.5) in summer. The use of grazing by ORG during summer improved milk production (+4.6 kg/cow/day) and decreased feed cost (-0.2 $/cow/day), which determined the highest milk IOFC. Our preliminary results indicate that, given 2010 prices, ORG could be as much profitable as CON or GRA systems when including the USDA's National Organic Program grazing standards.

Wisconsin dairy business and production survey: Comparison between farms planning to expand and farms not planning to expand

The survey was conducted to provide a comprehensive assessment of Wisconsin dairy operations. Key differences between expanding and non-expanding dairies were highlighted with additional focus on topics involving dairy expansion. Further priority was placed on maximizing the impact of a concurrent project concerning risk management in dairy production and expansion. Survey results highlight emerging trends among Wisconsin dairy farms and emphasize areas where further research and outreach programs are needed.

New-England dairy farm data for 1980-2010.

These datasets have been assembled and used to indicate to measure technical and environmental efficiency (Njuki et al., 2011). Several studies have been completed on nutrient management based on data from four CT dairy farms over five years for individual fields. One such study evaluates the implementation of nutrient management plans (NMPs) by comparing farmers' reported practices with recommended manure and fertilizer management, and the feasibility of using soil and corn tissue tests to document improvements in such management (Tao et al., 2010). A second study estimated changes in costs of manure handling, costs of the fertilizer replacement value of manure, and expected changes in net revenues associated with the implementation of NMPs. A third study analyzes the implementation of NMPs using econometric models (Tao et al., 2011).

Collaborative research with U-Fl on the Dairy Business Analysis Project (DBAP) data set is moving ahead. Significant progress has been made to assess the impact of local climatic conditions on milk production and farm efficiency. Econometric results indicate that heat stress has a significant negative impact on milk production and the effect is non-linear (Mukherjee et al., 2011).

An agreement has been made with the University of Kentucky by which UConn is able to use farm level data collected by the Kentucky Farm Business Management (KFBM) Program. Annual dairy production input and outputs are now available for more than 50 farms over a period of 13 years (Total observations = 433) to study. We are currently collecting weather information to match with this dairy data to address undertake research similar to what is mentioned in (3) above.

Herd turnover and mortality in low profile cross-ventilated and naturally ventilated dairy barns in the Upper Midwest.

The objective of this study was to describe herd turnover and mortality rates in low profile cross-ventilated barns (CV) compared with conventional naturally ventilated (NV) freestall barns. The study was conducted in 12 commercial dairy farms in Minnesota and eastern South Dakota. All farms had deep sand freestalls. Sold and died events were examined. Herd turnover rate was calculated as the number of animals that were sold or died during the year, divided by the average herd size. Mortality rate was calculated as the number of animals that died divided by average herd size. Seventeen categories were created for sold and died reasons: abortion, udder conformation, Johne's positive, mastitis, low milk production, reproduction, lame, metabolic problems, metritis, animals that were unable to rise, calving problems, injury, sick, miscellaneous, unknown, and no reason stated. Overall herd turnover rate was 26.8 ±3.2 and mortality was 5.4 ± 0.8. Herd turnover rates (LSMeans ± SE) were 24.6 ± 4.6 and 29.0 ± 4.6, and mortality rates were 5.8 ± 1.2 and 5.0 ± 1.2 in CV and NV barns, respectively. There were no differences between the 2 systems. Top 3 reasons for cattle to die on farm were sickness (33.6 ± 0.4), metabolic disease (9.5 ± 0.03), and injuries (8.6 ± 0.02) with no differences between CV and NV barns. Top reasons to be sold from the herd were low production (10.3 ± 0.1), mastitis (9.6 ± 0.1) and reproduction (8.6 ± 0.1). Cows housed in NV barns were more likely to be sold due to low milk production (21.9 ± 0.1 vs. 12.9 ± 0.1; $P < 0.001$) than cows housed in CV barns.

The CV barns reported selling more animals due to reproductive problems (16.0 ± 0.1 vs. 7.6 ± 0.1; $P < 0.001$) and mastitis (10.2 ± 0.1 vs. 6.0 ± 0.1; $P = 0.02$) than NV barns, respectively. Based on these results, CV and NV barns appeared similar for mortality and turnover rates.

Temperature and humidity in cross-ventilated and naturally ventilated dairy barns in the upper Midwest.

The objective of this study was to describe barn temperature, humidity, and some measurements of cow comfort in low profile cross-ventilated barns (CV) compared with conventional naturally ventilated freestall barns (NV). All NV barns used fans and soakers and all CV barns used evaporative cooling pads for heat abatement. Temperature and humidity were collected hourly inside the facility with data loggers and from the nearest weather station for the entire year. Cow comfort index (CCI) was calculated as the number of animals lying down in the stalls divided by total number of animals touching a stall (lying, 2 feet in a stall,or standing with all 4 feet in the stall) and it was measured 3 times during each visit. The CV barns were warmer in the winter than the NV barns (3.9 vs. −1.7°C; $P < 0.001$). There were no differences in temperature between CV and NV barns in spring, summer, or winter. However, summer temperature-humidity index (THI) was lower in CV than NV barns (65.9 vs. 68.5; $P < 0.001$). Respiration rates were not different between CV and NV barns (55.6 vs. 56.6 breaths/min, respectively). Outside THI was similar for CV and NV barns during respiration rate measurement (73.8 vs. 73.6). Each 1 unit increase in outside THI increased respiration rates by 0.26 ± 0.09. Overall CCI were 84.2, 85.2, 79.7, and 84.6 for winter, spring, summer, and fall, respectively. The CV barns had higher CCI than NV barns (84.2 vs. 75.3; $P = 0.047$) during the summer, with no differences in the other seasons. In conclusion, CV barns had greater CCI and lower THI during the summer than NV barns (possible indicators of improved cow comfort) although respiration rates did not differ.

Mortality and herd turnover rates in dairy herds utilizing recycled manure solids for bedding freestalls.

The objective of this study was to evaluate mortality and herd turnover rates in Midwest dairy herds utilizing recycled manure solids in deep bedded or mattress based freestalls. The study included 34 commercial dairy operations with herd sizes ranging from 100 to 3700 lactating cows. Forty-five percent of the herds had mattresses and 55% had deep bedded stalls. Sold and died events were examined. Overall mortality rate (mean ± SD) was 8.2 ± 3.1%. Main causes of death were miscellaneous or unknown reasons (63.6 ± 15.5), injuries (15 ± 8.9), and mastitis (12 ± 6.9). Overall herd turnover rate was 38.2 ± 6.9%. Main reasons for turnover were mastitis (19.5 ± 10.9), reproduction (15.8 ± 10.2), and low production (14.3 ± 14.8). Turnover rate during the first 60 DIM was 9.9 ± 3.4%. There was no association between stall surface and mortality. Mortality rates (LSmeans ± SE) were 8.2 ± 0.7 and 8.6 ± 0.9 for deep bedded and mattress herds, respectively. Herd turnover rates were 37.2 ± 1.7 and 38.6 ± 1.9 for deep bedded and mattress herds, respectively. No association was found between turnover rates and stall surface. There was a trend for stall surface to be associated with voluntary (dairy) and involuntary (other) reasons for removal ($P = 0.054$). Voluntary turnover was 16.7 ± 2.5 and 8.8 ± 3.1 for deep bedded and mattress, respectively. Sixty DIM turnover rates were 10.4 ± 0.09 for deep bedded herds and 9.5 ± 1.0 for mattress herds. Stall surface was not associated with 60 DIM turnover

rates. Results indicate stall surface had a relatively minor association with mortality and turnover rates in dairy herds using recycled manure solids as bedding.

Bedding management and characteristics of recycled manure solids used for bedding in Midwest freestall dairy herds.

The objectives of this study were to characterize RMS as a bedding material, observe bedding management practices, document methods for obtaining RMS, and describe housing facilities. We visited 38 Midwest dairy operations bedding freestalls with RMS to collect data. Methods of reclaiming manure solids for bedding included separation of anaerobic digested manure, separation of raw manure, and separation of raw manure followed by mechanical drum-composting for 18 to 24 h. Average bedding moisture of unused RMS was 72.4% with a pH of 9.16. Unused samples contained (on a dry basis) 1.4% N, 44.9% C, 32.7 C:N ratio, 4413 ppm P, 7038 ppm K, 76.5% NDF, 9.4% ash, 4.4% non-fiber carbohydrates, and 1.1% fat. Moisture was lowest for drum-composted solids prior to and after use as freestall bedding. After use in the stalls, digested solids had lower NDF content (70.5%) than drum-composted (75.0%) and separated raw (73.1%) solids. Total N content was greater in digested solids (2.0%) than separated raw (1.7%) solids. Total bacterial populations in unused bedding were greatest in separated raw manure solids but were similar between digested and drum-composted manure solids. Drum-composted manure solids had no coliform bacteria prior to use as freestall bedding. After use as bedding, digested manure solids had lower total bacteria counts compared to drum-composted and separated raw manure solids which had similar counts. Used bedding samples of digested solids contained fewer environmental streptococci bacteria than drum-composted and separated raw solids and had reduced bacillus counts in comparison to separated raw solids. Coliform counts were similar for all three bedding sources. Addition of a mechanical blower post-separation and use of a shelter for storage were associated with reduced fresh bedding moistures but not associated with bacterial counts.

Mortality patterns in Midwest DHIA herds.

The objective of this study was to describe the mortality patterns and identify risk factors for mortality in Midwest dairy herds. A total of 5,080,849 lactation records for cows that calved between January 2006 and December 2009 from 10 Midwest states were used. Overall mortality rate was 6.4 per 100 cow years. Herd level mortality rate was 5.6 ± 2.0 (mean ± SD). The distribution of mortality rates were estimated by categories of parity, stage of lactation and season. The association between mortality rate and different risk factors was investigated by using proportional hazards regression. Low first test day milk, parity, somatic cell score (SCS), fat to protein ratio (FPR), previous lactation dry period length, and breed were significantly associated with mortality ($P < 0.001$). Within herd, cows with higher 1st test day milk yield (>mean plus 1SD) had 0.95 times (5% less) hazard rate of mortality than cows with average milk yield (mean plus 1SD); however, cows with lower 1st test day milk yield (mean minus 1SD) had 1.49 times (49%) higher hazard rate of mortality than cows with average milk yield. Similarly, cows with FPR > 1.7 and < 1.0 at first test had 48 and 18%, respectively higher hazard rate of mortality than cows with FPR between 1.0 and 1.7. Every 1 unit increase in SCS was associated with a 6% increase in hazard rate of mortality. Cows with dry period >70 and <30 d had 1.38 and 1.22 times higher hazard rate of mortality, respectively than cows with dry period between 30

and 70 d. Crossbred cows had 14% less hazard rate of mortality than Holsteins; however, Jersey cows had 19% higher hazard rate of mortality than Holsteins. These results indicate that first test day records could be a useful tool to identify cows at high risk of mortality. In addition, higher milk yield was not associated with higher mortality.

Optimization of insemination, replacement, and calf selection decisions in seasonal herds under herd constraints.

The linear program has been extended to include seasonality in milk production, conception rates, and risks of involuntary culling and death. When all options are allowed, the model contains 70,000 variables and 200,000 constraints. Animal categories vary by parity (10), calendar week (52), insemination opportunity (15), type of semen (3), and whether the calf is raised or sold (3). Objective is to evaluate optimal strategies in seasonal herds. Typical herd constraints are a closed herd, herd size, parlor capacity, and milk quota. The model is used to evaluate the use of sexed and beef semen, embryo transfer, and value of improved fertility in Israel.

Economic evaluation of embryo transfer in dairy cows during the summer using linear programming.

The objective of this study was to estimate the economic value of the transfer of sexed female embryos (ET) to dairy cows in the summer compared to the use of conventional AI year round. Summer heat stress reduces fertility of dairy cows, but transfer of fresh sexed embryos in the summer may double the chance of pregnancy per transfer and result in more heifer calves. However, ET is more expensive than conventional AI, and the greater generation of pregnancies in the summer changes the calving pattern and seasonal cash flows. An economic analysis was carried out using a Markov chain dairy herd simulation model combined with linear programming. The model simulated cows from first calving up to the end of the ninth parity, used weekly steps, and assumed a 50% service rate. Seasonality was modeled as 52 periods per year. Heat stress was assumed to affect milk yield production, fat yield production, fertility, involuntary culling, and death risk. Decision variables were the number of purchased heifers per period. Embryo transfer was assumed to cost $60 per transfer compared to $20 per AI. Herd constraints were a maximum of 1300 cows (dry and lactating) or 1000 lactating cows during each week of the year. Results showed that the use of ET in the summer increased profit/cow per yr by $22 for the total cow constraint. Revenues were not changed, but the use of ET resulted in $39 less replacement cost per yr, as well as $20 greater total breeding costs and $3 greater feed cost. The useof ET reduced the maximum percentage of milking cows in the spring from 94% to 91% and reduced the number of dry cows. When the number of milking cows was the herd constraint, profit/milking cow per yr was increased by $42 when ET was used in the summer. Total costs were reduced by $4 per milking cow per yr and total revenues increased by $39, mostly due to increased milk sales and heifer calf sales. In conclusion, embryo transfer during the summer in heat stressed dairy cows is profitable, especially when the number of milking cows is the main constraint.

Optimal combinations in a closed herd: genomic testing, sexed semen, culling, genetic progress.

Sexed semen and reproductive programs allow for the creating of more dairy heifer calves than are needed to replace culled cows. Genomic testing allows for reliable ranking of animals for Net Merit breeding value. The question is how many heifer calves should be created, and which animals should be genomically tested, to obtain the maximum profitability in a closed herd. The linear programming model is used.

Economic value of an early non-pregnancy diagnosis test.

Monte Carlo simulation is used to evaluate the value and best use of a blood test that can determine non-pregnancy at 18 days after insemination.

Agreement between fat, protein, and lactose measurements from DHIA and the AfiLab™ real time milk analyzer.

AflLab measures fat, protein, and lactose on every milking for every cow. The questions is how well the agreement is with official DHI measures. DHI data from 19 testdays of approximately 460 cows each are compared with AfiLab measures.

Effect of precision feeding on performance and nutrient excretion of early lactation dairy cows.

Using daily milk and fat production and bodyweights, 29 cows were precision-fed (concentrate) for 100 days after calving. The precision fed cows generated on average $1.00 per cow per day more than the 29 control cows.

Weighted cost of capital on dairy farms in Florida.

Data from the Florida/Georgia Dairy Business Analysis Project was used to calculate the weighted cost of capital on dairy farms in Florida.

Survey of Genetic Selection Practices on Pasture-based Dairy Farms in the US.

A survey was mailed to dairy graziers across the country to ascertain their genetic selection practices, but included background information on feeding, production, and health. The overall aim was to collect data to allow eventual development of a genetic selection index. Mailing addresses were obtained from extension cooperators, NRCS advisors, and commercial companies. Producers were able to respond to the survey by mail or internet. Respondents to the survey included 77 farmers in 22 states. Producers were asked questions about the grazing history of their herd and average milk and component production. They were also asked questions about breeding practices to determine number utilizing seasonal grazing and to gain an understanding of breeds present in their herds. Producers were asked to rank genetic traits by the amount of selection pressure they felt should be applied to those commonly available. Traits were ranked from negative five to positive five with negative being selection against a trait and

positive being selection for a trait. Respondents averaged 15.95 ±9.12 years of grazing history, 129.1 ±128.52 milking head, and grazed 224.5 ±60.47 days a year. Production was 20.9 ±4.89 kg of milk per cow per day, 4.0 ±0.42% milk fat, and 3.6 ±0.23% milk protein. Also, 46.7% of producers participated in seasonal calving, defined as 75% of cattle calving in any 3 month window. Further, 70% utilized crossbreeding to the extent that at least 10% of the herd was crossbred. Percentage of herds that included at least some genetics from major breeds were: 70% Jersey, 65% Holstein, 26.7% Ayrshire, 21.7% Swedish or Norwegian Red, and 20% Milking Shorthorn. The average rank of genetic traits were: productive life 3.87, udder composite 3.57, somatic cell count -3.15, feet and legs 3.08, daughter pregnancy rate 3.05, fat percentage 2.97, calving ability 2.95, protein percentage 2.83, body size -2.73, fat yield 2.69, protein yield 2.56, and milk yield 2.27. It appears that pasture-based dairy producers place more emphasis on traits relating to longevity and fertility and less on production traits than the most widely used US

2. USEFULNESS OF FINDINGS

- Increasing fiber levels in precision feeding heifer programs can be beneficial in increasing protein and dry matter digestibility. This can result in a 4-6 percent improvement in N utilization over traditional heifer diets.
- When lactating dairy cows are offered diets which allow sorting, they will eat to a relatively constant diet particle size when given the opportunity to sort for longer or shorter forage particles.
- Improved newborn calf management can affect lifetime milk production in dairy cows.
- Opportunities exist to enhance dairy returns by utilizing specific tools to evaluate where changes is needed to improve income over feed costs and key areas of dairy production.
- Established that the inclusion of DDGS may improve the synthesis of rumen microbial protein in vitro.
- Established that feeding when feeding the cost effective feedstuff DDGS milk fat depression may be avoided my minimizing the level of starch and oil in the ration.
- Rations containing a high level of DDGS and fed to low producing dairy cows and not likely limiting in the essential AA lysine.
- The compost bedded pack barn work has resulted in an increased understanding of the compost bedded pack barn and associated best management practices. Technology research provides new insight into the utility of automated temperature monitoring.
- The results of recent survey work focused on milk quality can provide valuable information for extension professionals to utilize in efforts to increase milk production in Kentucky by demonstrating actual practices employed by top dairy producers.
- The inclusion of fat in dairy heifer diets is often thought to result in shorter, fatter heifers. Distillers grains is a cost-effective ingredient for dairy heifer diets that provides a source of dietary unsaturated fat. Intakes and rate of gain were similar across all treatments.
- Averages for hip and wither height, and body length were slightly less for the high fat diet compared to low fat diets, however the final frame size measurements at the end of the study were similar for all treatments.
- The inclusion of DDGS is often thought to negatively impact milk fat and protein composition through changes in ruminal fermentation and digestion; however the level of forage in the diet is also known to have an impact. Fiber digestion of DDGS may be less ruminally digested in low forage diets compared to high forage diets. Changes in the rumen can negatively impact milk composition.
- Supplementing diets with whole SS at 3% of dietary DM can be an effective strategy of fat supplementation to lactating dairy cows without negative effects on lactational performance and milk FA profiles.
- In vitro experiments showed that chestnut tannins exerted the greatest inhibition of pathogenic bacterial growth as well as rumen acidosis-causing bacteria. The mechanisms for antimicrobial activity in the chestnut tannins on the tested bacteria are not clear. The potential value of plant tannin extracts needs to be further tested on the mode of action of tannins against microorganisms, particularly the structure-reactivity relationship of each tannin component.

- While results of the heat stress project indicated no overall improvement in growth, providing shade did lower body temperature and respiration rates during the afternoon when heat stress was more severe. Incorporating resistant starch into milk replacer resulted in decreased fecal pH and increased fecal VFA, indicating that there may be some intestinal health benefits. More research is needed to further investigate effects of resistant starch in neonatal dairy calf diets.
- Feeding dietary coconut oil (a natural source of mainly medium chain fatty acids) can result in significant reductions in enteric methane emissions in lactating dairy cattle; however, does not appear to be a likely commercial candidate for dietary use because of marked reductions in feed intake, milk yield and milk fat concentration.
- This work is the first reported in the world of daily measurements whole animal enteric methane emissions under field conditions using this new measurement technology – the Greenfeed® system. The technology is very promising for measurement of enteric methane emissions under a variety of field conditions if the animals can be lured to a point for feeding and/or watering 2 to 4 times per day of measurement of expired and eructed air. The dairy feeding systems comparison in this study vividly highlights the importance of high milk production as a common strategy to affect methane emissions, and dilute methane emissions per unit of product produced, among all dairy systems.
- Field reports suggest adoption of limit feeding nutritional regimens for dairy heifers has occurred in the dairy industry.
- Results suggest that dairy producers and nutrition consultants do not need to feed or recommended dietary P above recommended levels to dairy heifers.
- Limited feeding with limited bunk space increase target growth variance and was not remediated by feeding straw. Dairy producers and nutrition consultants should recognize limit feeding can induce heifer growth variance if bunk space is not adequate.
- Adding sodium bicarbonate to pooled maternal colostrum did not alter IgG uptake. If colostrum replacer is fed in 1 dose than 30 g of $NaHCO_3$ is beneficial in enhancing IgG uptake. However, if 2 doses are fed, $NaHCO_3$ is not beneficial in enhancing IgG uptake. Chlortetracycline appears to improve ADG compared to control or lasalocid fed heifers.
- The linear program considers herd constraints and allows for economic evaluations that were not available earlier. Transfer of in-vitro fertilized embryos in the summer to increase conception rates appears to be economically feasible, especially if the number of milking cows is the constraint. An early blood test also appears to be economically feasible. Precision feeding of dairy cows generated increased income over feed cost, but implementation without self-feeders will be difficult. The Afilab system generated fat, protein, and lactose measurements that are moderately correlated (0.5 to 0.7) with DHI measures.
- It appears there are no clear advantages or disadvantages for sand, straw, or wood shavings as bedding materials with respect to calf growth, general health and hide contamination during moderate summer conditions in the Midwest. However, fly breeding and fly counts on calves are affected such that fly control is more critical when using straw.
- Although ensiled forages are commonly included in diets of growing dairy heifers, little research has been conducted to evaluate feeding baleage as a primary forage source. Heifers fed hay were 6.7 kg heavier than heifers fed baleage at the conclusion of the study. Heifers fed hay also gained 0.63 kg/d compared to 0.56 kg/d for heifers fed baleage. Overall, heifers fed hay consumed 0.30 kg more DM/d than baleage, resulting in a tendency for a 5.4% improvement in gain to feed ratios for hay compared to baleage. In summary, feeding

baleage decreased BW gain, but did not alter skeletal growth or rumen parameters in prepubertal dairy heifers.

- Rubber flooring in the feed alley for lactating cows may impact production, especially components, in first parity. Rubber flooring may affect cows surviving first lactation differently than those who do not. Future work with more cows is needed to ascertain results for traits like SCS and days open that inherently have higher environmental variation. Cortisol did not indicate an acute stress at any time in the first lactation, when evaluated by treatment or by a treatment for a condition that may lead to lameness in that lactation. The number of times that cows were given therapy for hoof or leg conditions was greater for cows housed on concrete. Changes in lymphocyte and total white blood cell counts in cows housed on concrete indicated chronic inflammation, but acute phase proteins did not. Flooring tends to affect cow hoof health, alters immune cell counts and influences production and herdlife. However, cost of rubber flooring to enhance cow comfort, which was not directly measured in this work, may not be justified solely in terms of yields and herdlife.
- The efficacy of storing WDGS with corn or hay crop silage before ensiling provides an opportunity for small or medium-sized dairy farms to utilize WDGS in their feeding and feed cost control strategies. Large farms are able to better utilize WDGS because they can feed the product quickly and before spoilage may occur. Farms unable to utilize an entire load of WDGS quickly will benefit from alternative storage opportunities without negative consequences on dairy cattle performance.
- A common question of dairy producers is whether similar growth and first lactation milk production can be achieved using pasture as the primary source of nutrition as compared to conventional diet and rearing in confined facilities. Pregnant heifers on pasture had increased ($P = 0.04$) average dairy gain, and reduced ($P = .001$) body condition score while skeletal growth rates as measured by whither height and hip height, were similar to conventionally fed heifers. Projected milk and fat yields did not differ while protein yields were increased ($P = 0.04$) by pasture. While pasture reduces body condition score, it can be used in pregnant heifers without detrimental effects on skeletal development or milk production.
- Findings show that calves can prosper from non-antibiotic supplements such as yeast/MOS products. Yeast/MOS products are the more cost-effective solution to removal of antibiotics from milk replacers and would be a good solution for feed manufacturers as well as producers, compared to more expensive beta-glucan isolates.
- Results showed that although less tolerant the heat stress, Holstein cows were still able to produce more milk in hot temperatures than Jersey cows.

3. PUBLICATIONS (Peer-reviewed Research and Extension)

Bewley, J.M., M.D. Boehlje, A.W. Gray, H. Hogeveen, S.J. Kenyon, S.D. Eicher, and M.M. Schutz. 2010. Assessing the Potential Value for an Automated Dairy Cattle Body Condition Scoring System through Stochastic Simulation. Agricultural Finance Rev. 70:126-150.

Bewley, J.M., M.D. Boehlje, A.W. Gray, H. Hogeveen, S.J. Kenyon, S.D. Eicher, and M.M. Schutz. 2010. Stochastic Simulation Using @Risk for Dairy Business Investment Decisions. Agricultural Finance Rev. 70:97-125.

Bewley, J.M., R.E. Boyce, D.J. Roberts, M.P. Coffey, M.M. Schutz. 2010. Comparison of two methods of assessing dairy cow body condition score. J. Dairy Res. 77:95-98.

Bewley, J.M., R.E. Boyce, J. Hockin, L. Munksgaard, S.D. Eicher, M.E. Einstein, and M.M. Schutz. 2010. Influence of milk yield, stage of lactation and body condition on dairy cattle lying behaviour using an automated activity monitoring sensor. Journal of Dairy Res. 77:1-6.

Bjelland, D., K. Weigel, P. Hoffman, N. Esser, and W. Coblentz. 2011. The effect of feeding dairy heifers diets with and without supplemental phosphorus on growth, reproductive efficiency, health, and lactation performance. J. Dairy Sci. 94:(in press).

Breuer, N.E., Cabrera, V.E., Hildebrand, P.E., and J.W. Jones. 2010. Opciones de manejo basadas en el clima para productores de ganado vacuno en el centro-norte de Florida. EDIS-University of Florida. (http://edis.ifas.ufl.edu/ae468).

Breuer, N.E., Fraisse, C.W., Cabrera, V.E. 2010. The Cooperative Extension Service as a boundary organization for diffusion of climate forecast: A 5-year study. Journal of Extension 4RIB7 (http://www.joe.org/joe/2010august/rb7.php).

C. M. Dschaak, C.M., C.M. Williams, M.S. Holt, J.-S. Eun, A.J. Young, and B.R. Min. 2011. Effects of supplementing condensed tannin extract on intake, digestion, ruminal fermentation, and milk production of lactating dairy cows. J. Dairy Sci. 94:2508-2519.

Cabral, R. G., C. E. Chapman, D. M. Haines, A. F. Brito, and P. S. Erickson. 2011. Short communication: Addition of varying amounts of sodium bicarbonate to colostrum replacer: Effects on IgG absorption and serum bicarbonate in neonatal calves. J. Dairy Sci. (In Press).

Cabrera, V. E., and P. E. Hildebrand. 2011. Chapter7: Linear programming for dairy herd simulation and optimization: An integrated approach for decision-making. IN Linear Programming - new frontiers and applications. Zoltan, A. M. (Eds), Nova Science Publishers, Inc, Hauppauge, NY.

Cabrera, V.E. 2010. A large Markovian linear program for replacement policies to optimize dairy herd net income for diets and nitrogen excretion. Journal of Dairy Science 93:394-406.

Cabrera, V.E., Janowski, J.M. 2011. Wisconsin dairy business and production survey: Comparison between farms planning to expand and farms not planning to expand. Journal of Extension 3RIB1 (http://www.joe.org/joe/2011june/rb1.php).

Cabrera, V.E., Solis, D., del Corral, J. 2010. Determinants of Technical Efficiency among Dairy Farms in Wisconsin. Journal of Dairy Science 93:387-393.

Castillo-Lopez, E., T. J. Klopfenstein, S. C. Fernando,* J. L. Miner* and P. J. Kononoff. 2011. The effect of dried distillers grains with solubles when replacing corn or soybean meal on rumen microbial growth in vitro as measured using real-time PCR. J. Anim. Sci. Submitted.

Chidmi, B., D. Solís and V. E. Cabrera. 2011. Analyzing the sources of technical efficiency among heterogeneous dairy farms: A quantile regression approach. Journal of Development and Agricultural Economics 3(7): 318–324.

Cole, J. B., D. J. Null, and A. De Vries. 2011. Short communication: Best prediction of 305-day lactation yields with regional and seasonal effects. J. Dairy Sci. 94(3):1601-1604.

De Vries, A., D. T. Galligan, and J. B. Cole. 2011. The use and economic value of the 3K SNP genomic test for calves on dairy farms. EDIS Document AN270.

Diaz Royón, F., A. García, and K. Kalscheur. 2011. Alimentación de la vaca seca. South Dakota State University, Cooperative Extension Service. ExEx4047S.

Diaz Royón, F., A. García, and K. Kalscheur. 2011. Feeding the Dry Cow. South Dakota State University, Cooperative Extension Service. ExEx4047.

Dschaak, C.M., C.T. Noviandi, J.-S. Eun , V. Fellner, A. J. Young, D. R. ZoBell, and C. E. Israelsen. 2011. Ruminal fermentation, milk fatty acid profiles, and productive performance of Holstein dairy cows fed 2 different safflower seeds. J. Dairy Sci. 94: 5138-5150.

Elizondo-Salazar, J. A., C. M. Jones, and A. J. Heinrichs. 2011. Feeding Colostrum with an Esophageal Feeder Does Not Reduce Immunoglobulin G Absorption in Neonatal Dairy Heifer Calves. Professional Animal Scientist. (accepted, in press).

Erickson, P.S., N.L. Whitehouse, and M.L. Dunn. 2011. Activated carbon supplementation of dairy cow diets: effects on apparent total-tract nutrient digestibility and taste preference. Prof. Anim. Sci. 27:428-434.

Fustini,M., A. Palmonari, E. Bucchi, A. J. Heinrichs, A. Formigoni. 2011. Chewing and ruminating with various forage qualities in nonlactating dairy cows. Professional Animal Scientist. 27:352-356.

Giordano, J. O., P. M. Fricke, M. C. Wiltbank, and V. E. Cabrera. 2011. An economic decision-making support system for selection of reproductive management programs on dairy farms. J. Dairy Sci. (in press).

Heinrichs, A. J. and B. S. Heinrichs. 2011. A prospective study of calf factors affecting first lactation and lifetime milk production. J. Dairy Sci. 94: 336-341.

Holden, L.A., J.A. Hyde, B. J. Hilty, and E. Cowan. 2011. Challenges and Opportunities for New and Beginning Dairy Producers: A Pennsylvania Perspective. J. of Extension www.joe.org/joe/2011june/rb2.php

Hollmann, M., M. S. Allen, and D. K. Beede. 2011. Diet fermentability influences lactational performance responses to distiller's grains: A meta analysis. J. Dairy Sci. 94: 2007 – 2021.

Hollmann, M., M. S. Allen, and D. K. Beede. 2011. Dietary protein quality and quantity affect lactational responses to distiller's grains: A meta analysis. J. Dairy Sci. 94: 2022 – 2030.

Hyde, J., S. A. Cornelisse, and L. A. Holden, 2011. "Human resource management on dairy farms: Does investing in people matter?", Economics Bulletin, Vol. 31 No. 1 pp. 208-217.

Inostroza, J.F., Shaver, R.D., Cabrera, V.E., and Tricarico, J.M. 2010. Effect of diets containing a controlled-release urea product on milk yield, composition and component yields in commercial Wisconsin dairy herds and economic implications. Professional Animal Scientist 26:175-180.

Kalscheur, K.F., A.R. Hippen, and A.D. Garcia. 2011. Feeding distillers grains products to dairy cattle. Pages 259-289 in Distillers Grains: Production, Properties, and Utilization. K.A. Rosentrater and K. Liu (eds.), AOCS, Urbana, IL.

Kehoe, S. I., A. J. Heinrichs, M. L. Moody, C. M. Jones, and M. R. Long. 2011. Comparison of Immunoglobulin G Concentrations in Primiparous and Multiparous Bovine Colostrum. Professional Animal Scientist. 27: 176-180.

Kruse K.A., D.K. Combs, N.M. Esser, W.K. Coblentz, P.C. Hoffman. 2010. Evaluation of potential carryover effects associated with limit feeding of gravid Holstein heifers. J. Dairy Sci. 93:5374-5384.

Lascano, G. J. 2011. Optimizing nutrient utilization of a precision feeding system for dairy heifers using low and high forage diets. PhD Thesis. The Pennsylvania State University, University Park, PA 340 pp.

Lascano, G. J., and A. J. Heinrichs. 2011. Effects of feeding different levels of dietary fiber through the addition of corn stover in nutrient utilization of dairy heifers precision-fed high and low concentrate diets. J. Dairy Sci. 94: 3025-3036.

Lascano, G. J., M. Velez, J. M. Tricarico, and A. J. Heinrichs. 2011. Nutrient utilization of fresh sugar cane-based diets with slow-release non protein nitrogen addition for control-fed dairy heifers. J. Dairy Sci. (accepted, in press).

Marston, S.P., G.W. Clark, G.W. Anderson, R.J. Kersbergen, M. Lunak, D.P. Marcinkowski, M.R. Murphy, C.G. Schwab, and P.S. Erickson. 2011. Maximizing profit on New England organic dairy farms: An economic comparison of four total mixed rations for organic Holsteins and Jerseys. J. Dairy Sci. 94:3184-3201.

Maulfair D. D. 2011. Forage particle size and ration sorting in lactating dairy cows. Ph.D. Thesis. The Pennsylvania State University. University Park, PA. 218 pp.

Maulfair, D. D., M. Fustini, and A. J. Heinrichs. 2011. Effect of feed sorting on rumen digesta and fecal particle size and digestibility in lactating dairy cows. J. Dairy. Sci. 94: 3576-3581.

Mjoun, K., K. F. Kalscheur, and A. D. Garcia. 2011. Fermentation characteristics and aerobic stability of wet corn distillers grains ensiled in combination with whole plant corn. J. Sci. Food Agric. 91:1336-1340.

Pinzón-Sánchez, C., V. E. Cabrera and P.L. Ruegg. 2011. Decision tree analysis of treatment strategies for mild and moderate cases of clinical mastitis. Journal of Dairy Sci. 94:1873-1892.

Quezada-Mendoza, V. C., A.J. Heinrichs, and C.M. Jones. 2011. The effects of a prebiotic supplement (Prebio Support) on fecal and salivary IgA in neonatal dairy calves. Livestock Science. DOI: 10.1016/j.livsci.2011.07.015.

Ramirez Ramirez, H.A., K. Nestor, L.O. Tedeschi, T.R. Callaway, S.E. Dowd, S.C. Fernando, and P.J. Kononoff. 2011. The effect of brown midrib corn silage and dried distillers grains and solubles on milk production nitrogen utilization, and microbial community structure in dairy cows. J. Dairy Science. Submitted.

Ramirez–Ramirez, H.A., A.R. Geis, C.S. Heine, K.J. Machacek, A. M. Gehman, and P. J. Kononoff. 2011. Study of storage conditions of wet corn distillers grains with solubles when stored with other feeds and understanding effects on performance of lactating dairy cows. Can. J. Anim. Sci. 91: 331-339.

Russell, R.A. and J.M. Bewley. 2011. Producer assessment of dairy extension programming in Kentucky. J. Dairy Sci. 94: 2637-2647.

Shane, E.M., M.I. Endres, M.P. Russelle, C.J. Rosen, and D.G. Johnson. 2011. Compost: A potential value-added product for dairy operations? Appl. Eng. Agric. 27(2):225-233.

Suarez-Mena, X. F., T. M. Hill, A. J. Heinrichs, H. G. Bateman, II, J. M. Aldrich, and R. L. Schlotterbeck. 2011. Effects of including corn distillers dried grains with solubles in dairy calf feeds. J. Dairy Sci. 94: 2438-2451.

Tao, H., T, F. Morris, B. E. Bravo-Ureta, R. Meinert, K. Zanger, and J. Neafsey. "A Partial Budget Analysis for Phosphorus-Based Nutrient Management Plans for Connecticut Dairy Farms." Agronomy Journal 102(2010):231-240.

Valvekar, M., Cabrera, V.E., Gould, B.W. 2010. Identifying optimal strategies for guaranteeing target dairy income over feed cost. Journal of Dairy Science 93:3350-3357.

Valvekar, M., J. P. Chavas, B. W. Gould, and V. E. Cabrera. 2011. Revenue risk management, risk aversion and the use of Livestock Gross Margin for Dairy Cattle insurance. Ag. Systems 104:671-678.

Williams, C.M., J.-S. Eun,, J.W. MacAdam, A.J. Young, V. Fellner, B.R. Min. 2011. Effects of forage legumes containing condensed tannins on methane and ammonia production in continuous cultures of mixed ruminal microorganisms. Anim. Feed Sci. Technol. doi:10.1016/j.anifeedsci.2011.04.025

4. IMPACT STATEMENTS

- Fiber levels of dairy heifer rations can greatly impact digestibility and nutrient content of manure from precision fed dairy heifers. This could mean reducing manure production by 10-30% from heifer herds and could reduce nitrogen by 5-10% from traditional low quality high forage feeding systems.
- Data from the Penn State and Ro-Tap particle separators produced different particle size distributions from the same sample. This indicates that data obtained from these 2 methods of particle separation are not directly comparable and that the method of particle separation should be considered when interpreting experimental or forage analysis results.
- Improvements in dairy farm profitability can be made through focus increasing income over feed costs and by systematically identifying bottlenecks in production and financial management using benchmarking.
- The use of commercial dairy calves for nutritional and management studies up to 6 months of age and the ability to follow these calves back to their respective dairy herds for first lactation performance provides a critical base towards attaining objective 1 of the NC-1042 project. In terms of application of the results to the field, benchmarks have been developed for calf performance parameters that have been used for on-farm comparisons across the US. The addition of research data on organic production systems for dairy youngstock will be an important diversification for the project revision.
- Feeding fat from distillers grain resulted in slightly smaller frame size, and greater BCS in overall averages. But ADG and feed efficiency were similar between treatments. Including fat from DDGS in growing heifer diets, while providing for recommended energy requirements, results in similar body growth compared to feeding concentrates containing corn and soybean meal.
- The addition of DDGS as a replacement for ground corn or soybean feedstuffs alters rumen fermentation and nutrient digestibility at a low forage level compared to a high forage diet. Fiber digestibility of DDGS is lower when fed in a low forage diet. Higher concentrations of forage fiber may have a positive associative effect on the fiber digestibility of DDGS.
- Dairy farms are under pressure to increase production, but reduce input costs. Feed costs are the single highest expense on a dairy. Safflower is commonly grown in the Intermountain west and is readily available as a feed source. We have now determined that it can be fed to lactating cows at a maximum of 3% of the diet. Feeding whole safflower can be a viable alternative to feeding whole cottonseed in terms of fat source.
- Plant tannins seem to have antimicrobial activity on pathogenic and rumen acidosis causing bacteria. They may be useful in the future to replace the use of antibiotic feed additives in livestock.

- Continued emphasis on growth and development of heifers will ultimately add to improved production efficiency in dairy operations. These animals are the future milking cows, and research must continue to identify management strategies that can improve performance of these valuable animals.
- Efforts focused on mitigation and measurement of enteric methane from lactating dairy cows. In one series of experiments coconut oil, a source of predominantly medium chain (C-12 and C-14) fatty acids, was thoroughly evaluated characterizing the potential reduction of methane emissions and nutritional, ruminal and metabolic effects on lactational performance. Marked reduction in methane emissions was found, presumably due to effects on the rumen microbial ecosystem as well as reduced feed intake. However, lactational performance was detrimentally affected to the degree that coconut oil is not likely a viable commercial feed ingredient unless revenue from the lost milk production could be recovered by new revenue generation for the amount of methane reduction.
- Alternatively identifying and evaluating major management differences in whole feeding systems shows promise to identify significant differences in methane emissions per unit of edible product (e.g., milk) generated. A new, easier technology to measure enteric methane production under field conditions was tested and has great promise.
- Dairy producers in Wisconsin and elsewhere are always looking for cost-efficient and profitable management strategies to improve their bottom-line and guarantee their long-term economic and environmental sustainability. Dairy producers have indicated that they need support in making complex planning decisions to improve their efficiency of production, profitability, and for the dairy industry to remain sustainable.
- Management information systems are increasingly important for helping in the decision-making of dairy systems. Indeed, dairy farming is a decision-intensive enterprise where profitable decisions cannot be made without the use of decision aids. The dynamics of dairy farm systems warrants the utilization of sophisticated techniques to assess the impacts of management strategies to farm economics, which at the same time need to be user-friendly and ready to be applied at the farm level. Simulation techniques help to overcome these shortcomings assessing cost-efficiency and profitability even under highly uncertain scenarios.
- Our programs are committed to provide relevant, up-to-date, research based, and field tested decision aids to farmers, extension agents. Projects have enhanced the understanding of nutrient requirements and behavior of growing dairy heifers and identify nutritional strategies that maximize the efficient use of dietary nutrients and reduce excretion into the environment.
- Reduction of heat stress with cross-ventilated barns can potentially translate into more milk production, better reproduction and less lameness, with major implications on profitability. Use of recycled solids for bedding can result in cost savings for dairy operations while improving animal well-being compared to certain types of freestall

systems. Mortality rates on dairy farms are an economic and welfare concern, therefore identifying risk factors for mortality can improve sustainability of the dairy industry.

- Colostrum replacer (based on dehydrated colostrum) provides adequate immunity based on blood IgG concentration. Adding sodium bicarbonate to colostrum replacer was beneficial if it is fed in a single feeding. Adding 30 g of sodium bicarbonate to 4 L of colostrum was not beneficial.
- The cost of raising dairy heifers is typically the second highest expense for dairy producers. Strategies that improve the feed efficiency and growth rates of heifers will improve the economic sustainability of dairy operations. A study found that feeding dairy heifers dry hay as compared to baleage improved average daily gain of dairy heifers. In another study, co-grazing dairy heifers and meat goats helped to reduce the presence of weeds in pastures without negatively affecting gains of the dairy heifers. Incorporation of various feeding strategies can help to reduce the cost of raising dairy heifers.
- The efficacy of storing WDGS with corn or hay crop silage before ensiling provides an opportunity for small or medium-sized dairy farms to utilize WDGS in their feeding and feed cost control strategies. Large farms are able to better utilize WDGS because they can feed the product quickly and before spoilage may occur. Farms unable to utilize an entire load of WDGS quickly will benefit from alternative storage opportunities without negative consequences on dairy cattle performance.
- Grazing dairy operations place emphasis on different traits for their cows than confinement dairy operations. Understanding the needs and preferences of grazing dairy operators will assist in the development of a New Merit Index for selecting sires for grazing operations. A new index will allow graziers to more easily select bulls when breeding their cows.
- The heifer enterprise on dairy farms is usually considered to be approximately 20% of the cost of operating a dairy herd and 70% of heifer raising is made up of feed costs. Thus, this research is aimed at improving profitability of the dairy farm operation through reduced feeding costs.
- Heifer replacements are one of the greatest expenses in dairy farm operations. Improving growth, feed efficiency, and health in heifers will ultimately improve the sustainability and increase profitability of dairy farms.
- Heat stress can also have severe negative impacts on milk production, heifer growth, and overall farm profitability. Research on management practices to reduce the negative effects of heat stress will not only improve cow and heifer health, production, and comfort, but also reduce production losses and increase profitability at the whole farm level.

5. LEVERAGE

Holden, L., R. White, R. Goodling, V. Ishler, K. Baase, and A. Kitsos. Tools for Teams: Improving the success of advisory teams to benefit overall farm performance. $104,000. Submitted to NESARE. (Pending)

C. S. Dose, T. C. Jenkins, L. O. Tedeschi, and K. Kononoff, P.J. 2007. Nebraska Corn Board. Milk Fat Depression and Wet Distillers Grains and Solubles. $35, 855.00. Status: Funded.

Bewley, J.M., A.E. Sterrett, W.J. Silvia, L.M. Arnold. E. Aalseth, R.J. Harmon, M. Rossano. 2011-2014. Quantification of physiological and behavioral indicators of disease in dairy cattle using Precision Dairy Farming technologies. $139,472. Donations from IceRobotics, Milkline, SCR Engineers, and DVM Systems.

Bewley, J.M., G. Heersche, and W.J. Silvia. Reproductive Management Programs that do not Utilize Visual Detection of Estrus: A comparison of a Timed Artificial Insemination Program versus a Program based on Monitoring Cow Movement and Activity. $87,500. SAE Afikim Research Support.

Bewley, J.M. Technical and economic implications of the use of waterbeds as a freestall base in dairy herds. 2011-2013. $65,000. Advanced Comfort Technologies Research Support.

Bewley, J.M., T.S. Stombaugh, E.S. Vanzant, and J.L. Taraba. 2011-2012. Impact of Animal Position within Dairy Compost Bedded Pack Barns on Animal Performance and Implications for Barn Design. $50,000. Precision Resource Management Special Grant.

Hippen, A. R., K. F. Kalscheur, and D. J. Schingoethe. New uses of distillers grains products in dairy cattle feeding. 5/1/2010 to 4/30/2011. USDA/ARS. $72,500.

Strategic approaches to develop optimal feeding program of brown midrib corn silage to lactating dairy cows in the Intermountain West Mycogen Seeds; Total request: $82,532.21; Duration: 2011 – 2012 (A. Young).

Improved organic milk production through the use of the condensed tannin-containing forage legume birdsfoot trefoil. USDA-NIFA Organic Agriculture Research and Extension Initiative (competitive grant program), Total request: $1,019,411.00 ($16,446 as a co-PI), Duration: 2011 – 2016 (A. Young).

USDA-AFRI-ERS. 2012-2015. Interaction between productivity growth and environmental factors for multi-output farms with a dairy focus. Bravo-Ureta, A. De Vries, R. Mosheim, V. E. Cabrera.

$5,000,000. 2011-2016. USDA Agriculture and Food Research Initiative. Genomic Selection and Herd Management Tools to Improve Feed Efficiency of the Dairy Industry. Van de Haar, M. (Michigan State University, PI), Cabrera, V.E., and other 14 in distinct U.S. and European universities. ACTIVE.

$1,000,000. 03/15/10-03/14/14. An integrated approach to improving dairy cow fertility. Cabrera, V.E. (PI), Fricke, P., Shaver, R., Ruegg, P., Weigel, K, Wiltbank, M. ACTIVE.

$574,621. 01/15/10-01/14/14. USDA Organic Research and Education Initiative. Strategies of Pasture Supplementation on Organic and Conventional Grazing Dairies: Assessment of Economic, Production and Environmental Outcomes. Cabrera, V.E. (PI), Gildersleeve, R., Wattiaux, M., Combs, D. ACTIVE.

$150,000. 09/01/09-08/31/13. USDA International Science and Education (ISE) Competitive Grant Program. Integrated Analysis of Diverse Dairy Systems in Mexico and Wisconsin: Building Capacity for Multidisciplinary Appraisal of Sustainability. Wattiaux, M. (PI), Barham, B., Bell, M., Cabrera, V.E., Harrison Pritkin, J. ACTIVE.

$83,000. 10/01/11-09/30/13. USDA Hatch Funding. Development of a suite of dairy reproduction decision support tools. Cabrera, V.E. ACTIVE.

$76,000. 06/30/10 to 09/30/12. Energy Intensity, Carbon Footprint and Environmental Impact of Pasture based Dairy. Grazing Lands Conservation Initiative Grants. Reinemann, D.J. (PI), Cabrera, V.E. ACTIVE.

$47,000. 07/01/10 to 12/31/11. USDA North Central Risk Management Education Center. A sustainable Wisconsin dairy farm financial management model. Bolton, K., Cabrera, V.E. (co-PIs). ACTIVE.

$10, 000 to conduct a study to determine if adding sodium bicarbonate to colostrum enhances IgG uptake. (The Walker Milk Fund). P. Erickson.

Nennich, T. D., and J. Tower. 2010. Dairy heifer feeding strategies to improve animal performance during transition periods. Mary S. Rice Grant. $6,000.

Nennich, T., J. Townsend, M. Schutz, and K. Ilelegi. 2011. Evaluation of factors limiting DDGS inclusion in dairy diets. Indiana Corn Marketing Council. $27,900.

$30,000 from Novus International, Inc to study the effects of yeast additives in young calf diets

$1,000 from MS State Shackoul's Honor College to support undergraduate research in Shade type preference in Holstein heifers